CALIFORNIA BLUEBERRY COMMISSION
ANNUAL REPORT
2017-2018

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CALIFORNIA Blueberry COMMISSION

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MESSAGE FROM THE EXECUTIVE DIRECTOR

Todd Sanders
Executive Director

In 2018, California continued to be a leader within the blueberry industry even though several challenges presented themselves including pest and disease concerns, legislative and regulatory issues, labor matters, and a decrease in volume due to an early frost. Additionally, trade disruptions and political differences added to an already difficult market. Despite these challenges, the California blueberry industry finished close to a record high in total production and continued to remain competitive.

In 2018, the California Blueberry Commission entered its eighth year of representing the California blueberry industry and the Commission continues to make strides in the areas it is tasked to manage. Some of these responsibilities include: research, export issues, industry communication, and BMRIC. Within this report is a breakdown of some of the activities that the Commission has participated in over the last season and what to expect in the future.

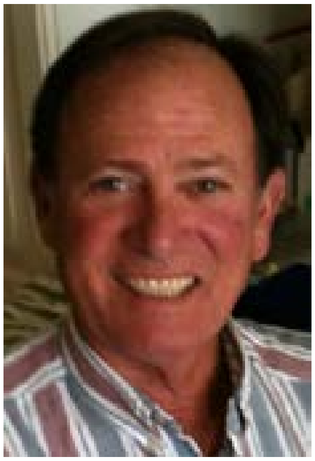
Additionally, the Commission continues to develop and foster necessary relationships within the industry to assist on items that directly impact the California blueberry industry. These organizations include: the International Blueberry Organization (IBO), the U.S. Highbush Council (the federal marketing order for the U.S. Blueberry industry), the North American Blueberry Council, Buy California Marketing Agreement (CA Grown), the Produce Marketing Association (PMA), and United Fresh, among others.

Finally, the California Blueberry Commission as gone through a leadership change. Alex Ott, the former Executive Director of the Commission, stepped down in June 2018 to pursue an opportunity with the American Pecan Council. Over the last 7 years, the California blueberry industry benefited from his leadership and guidance, and we are extremely appreciative.

On behalf of the California Blueberry Commission, I am pleased to submit the 2017-2018 Annual report. Thank you again, for your continued support of the California Blueberry Commission. We continue to look forward to serving you in the next year.

Todd Sanders
Executive Director

THE CHAIRMAN'S CORNER



Buck Klein
Chairman

In the face of some difficulties and setbacks during the 2017-2018 season, the California Blueberry industry continued to grow and build momentum. Some of these difficulties that the blueberry industry experienced included the implementation of new wage and overtime laws, more stringent environmental rules, the Food Safety and Modernization Act (FSMA), and weather related issues. Despite these hindrances, the California blueberry industry nearly finished at a record high in production volume, and the future looks bright.

The 2017-2018 annual report highlights the numerous projects and undertakings that the Commission has completed or is working on throughout the year. Within this report are updates on Commission research projects, market access assessments, pest and disease information, BMRIC statistics, domestic and export statistics, a FSMA update, and other pertinent industry materials.

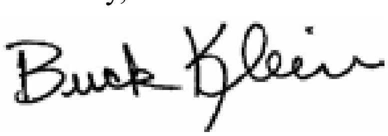
Some areas to highlight this year include partnering with the California Cherry Advisory Board on two projects: research on spotted wing drosophila and a California cherry and blueberry specific promotional campaign in Japan. Additionally, please look at the new rules and regulations outlining the upcoming FSMA law. These are very important as the Food and Drug Administration (FDA) will begin to enforce FSMA this year.

I would like to take the opportunity to say thank you to Alexander Ott, our Executive Director, and congratulate him on his new position with the American Pecan Council. I have no doubt that our new leadership team, led by Todd Sanders, will continue to represent and guide the California Blueberry Commission with great success.

Lastly, after serving on the board for 8 years, I will be stepping down as the Chairman of the California Blueberry Commission. Although I will no longer serve as Chairman, I will remain on the board and continue to play an active role in the blueberry industry. Effective October 1, 2018, Brian Caster will lead the Commission as the Chairman, and I know that Brian will continue our successes into future years.

Thank you again for the opportunity to be your Chairman and thank you for your support of the Commission. I look forward to a successful 2018 – 2019 season for the California Blueberry industry.

Sincerely,



Buck Klein
Chairman

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BOARD OF DIRECTORS

District 1Producer Members	District 2Producer Members	District 3 Producer Members
VACANT Term Ends: 9/2018	Dennis Burreson Burreson Farms Term Ends: 9/2019	Tobin Martin Maricopa Orchards, LLC Term Ends: 9/ 2018

Alternate Producer Member	Alternate Producer Member	Alternate Producer Member
Will Gerry Coastal CA Blueberry Farm Term Ends: 9/ 2018	Stan Kaufman KY Farming, Inc. Term Ends: 9/2019	Young Kwun Tabitha Max Blueberry Farms Term Ends: 9/ 2018

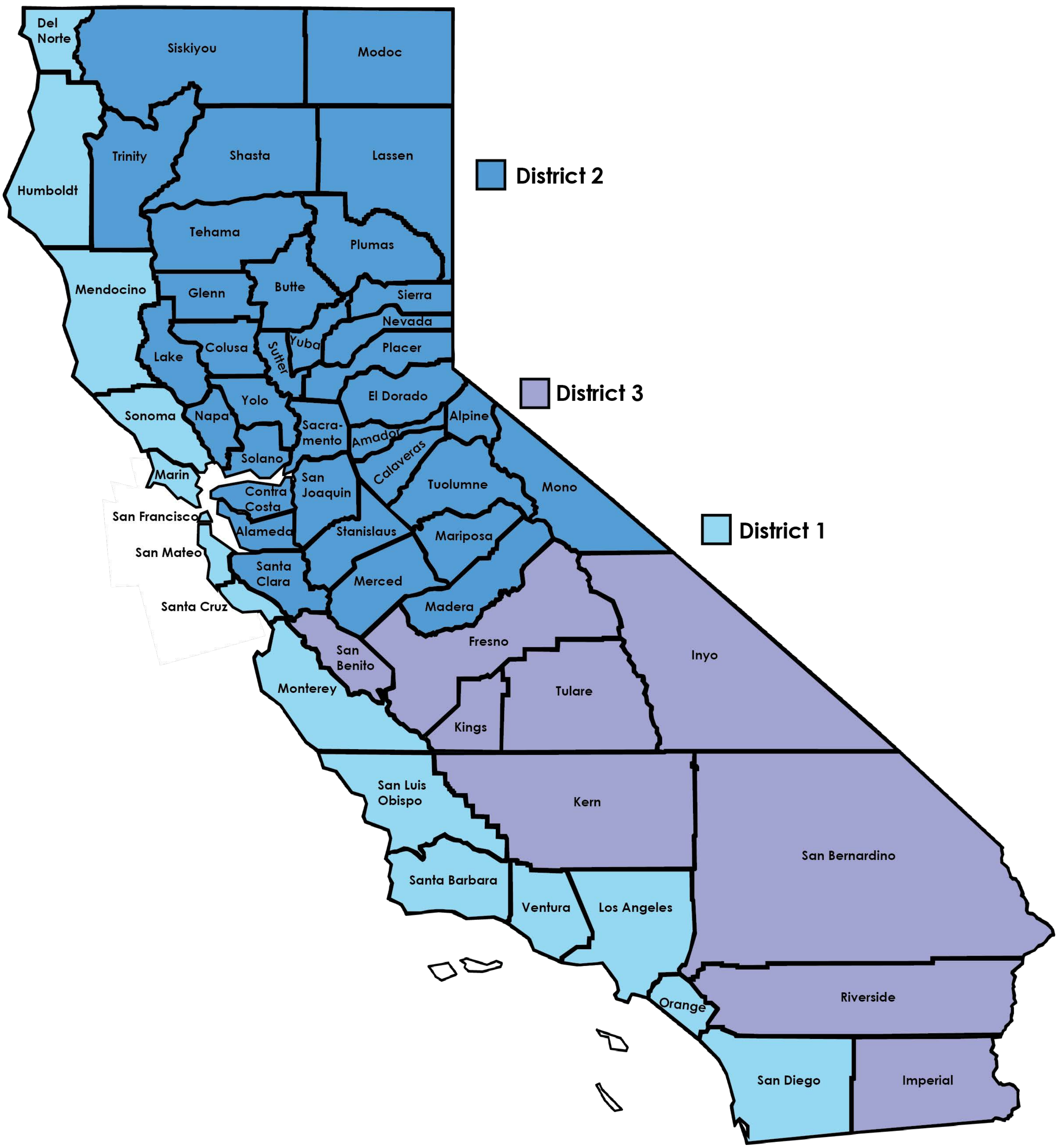
District 1Handler Members	District 2 Handler Members	District 3 Handler Members
Bill Steed Fairfield Farms, LLC Term Ends: 9/ 2018	Kewel (Kable) Munger Naturipe Farms, LLC Term Ends: 9/ 2018	Doug Perkins HBF International, LLC Term Ends: 9/ 2018
Chad Hansen Homegrown Organic Foods Term Ends: 9/2019	Jayson Scarborough Academy Fruit Company, LLC Term Ends: 9/2019	

Alternate Handler Members		
Dan Clenney Family Tree Farms Term Ends: 9/2018	Chase Higginbotham Dole Packaged Foods, LLC Term Ends: 9/2018	Guy Cotton Grower Direct/OG Packing Term Ends: 9/2019
Brian Caster Driscoll's Term Ends: 9/2018	Thomas Avinelis Agricare, Inc. Term Ends: 9/2019	

First Statewide Position	Second Statewide Position	Public Member
Jon Marthedal Marthedal Farms Term Ends: 9/2019	Buck Klein (Chair) Gourmet Blueberry-CA Term Ends: 9/2019	VACANT Term Ends: 9/2019

Alternate First Statewide Position	Alternate Second Statewide Position	Alternate Public Member
Scott Critchley Critchley Family Farms Term Ends: 9/2019	Baldev (David) Munger Munger Farms Term Ends: 9/2019	VACANT Term Ends: 9/2019

DISTRICT MAP



BLUEBERRY ACREAGE TOTALS

County	Acreage
Calaveras	2.00
El Dorado and Alpine	35.00
Fresno	1,190.00
Glenn	175.10
Kern	1,755.00
Kings	56.00
Madera	11.80
Merced	4.00
Monterey	35.00
Napa	.02
Nevada	2.62
Placer	<1.00
Sacramento	3.00
San Benito	32.00
San Diego	292.00
San Joaquin	1590.00
San Luis Obispo	212.00
San Mateo	.01
Santa Barbara	308.00
Santa Cruz	78.20
Shasta	.10
Sonoma	15.00
Stanislaus	39.00
Tehama	6.90
Tulare	2347.81
Ventura	559.00
Yolo	3.00
Yuba	1.00
Total:	**8,754.56**

STATEMENT OF ACTIVITIES

FISCAL YEAR ENDED SEPTEMBER, 2017

ASSETS

• CASH	$626,097
• ACCOUNTS RECEIVABLE	$ 77,788
• PREPAID EXPENSES	$ 2,486
• PROPERTY & EQUIPMENT	$ 1,611
TOTAL ASSETS	**$707,982**

LIABILITIES

• ACCOUNTS PAYABLE	$ 33,805
• CURRENT PORTION OF LONG-TERM DEBT ACCRUED	$ 4,257
TOTAL CURRENT LIABILITIES	**$ 55,086**

NET ASSETS

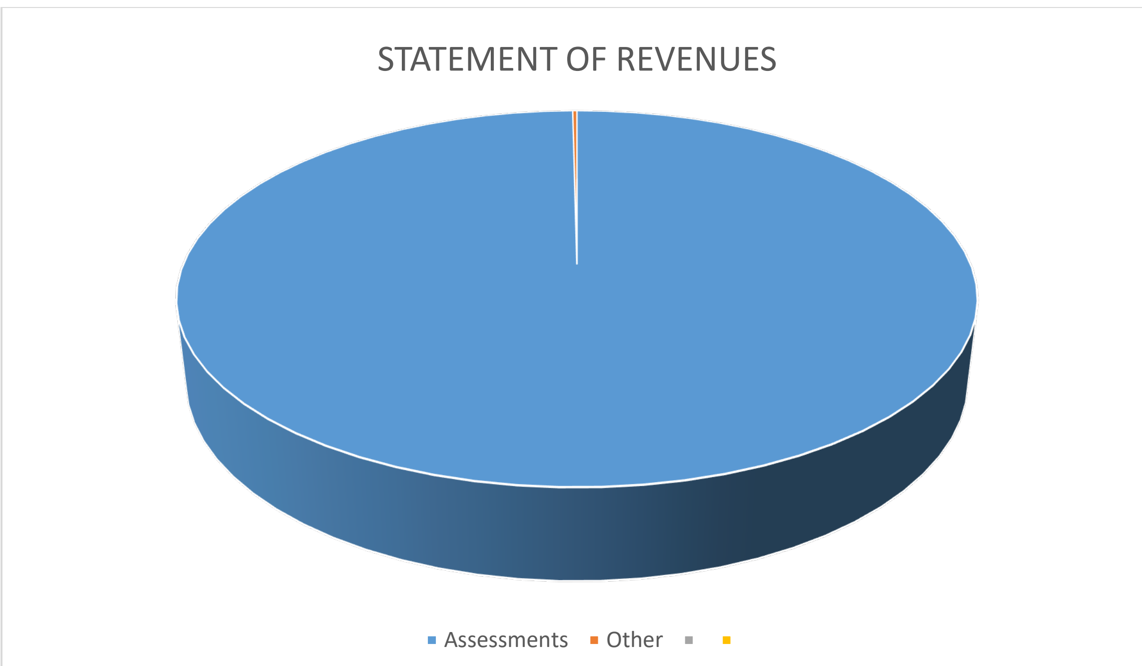
• UNRESTRICTED	$652,896

TOTAL LIABILITIES AND NET ASSETS	**$707,982**

STATEMENT OF REVENUES

REVENUES

• ASSESSMENTS	$368,417
• GRANT INCOME – TASC	$0
• OTHER	$747
TOTAL REVENUES	**$369,164**

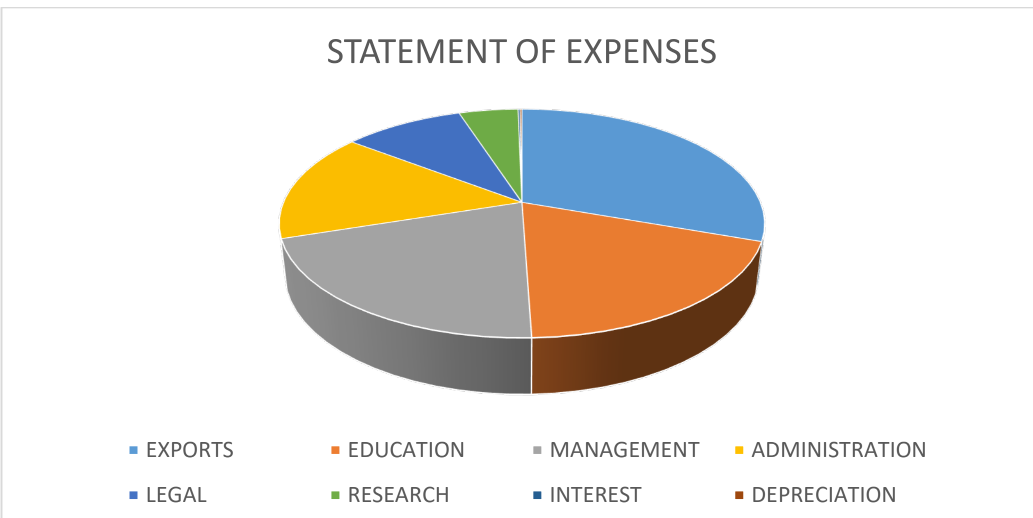


STATEMENT OF EXPENSES

<u>EXPENSES</u>

• EXPORT/MARKET DEVELOPMENT	$96,396
• EDUCATION	$60,397
• MANAGEMENT	$65,000
• ADMINISTRATION	$48,906
• LEGAL	$30,364
• RESEARCH	$14,925
• INTEREST	$511
• DEPRECIATION	$461

TOTAL EXPENSES	**$316,960**



CHANGES IN NET POSITION	**$52,204**
NET ASSETS, BEGINNING OF YEAR	**$600,692**
NET ASSETS, END OF YEAR	**$652,896**

BLUEBERRY RESEARCH

2017-2018 RESEARCH SUMMARY

In 2017-2018, the California Blueberry Commission focused on two research projects. These research reports are a continuation of prior research, and will continue in the future.

The above stated research projects are as listed below:

1) The postharvest treatments of California blueberries to eliminate insects with potential to serve as export trade barriers. - Dr. Spencer Walse

2) Engineered transgenic Drosophila suzukii for wild population suppression and eradication: production, performance assessment, and effective wild releases. - Dr. Omar S. Akbari

It should be noted that the California Department of Food and Agriculture (CDFA) was preparing to elevate Blueberry Rust to a class A pest. However, thanks to the Commission's efforts and members comments, the pest was appropriately downgraded to a class C pest. The Commission will continue to monitor research and pest and disease issues that will directly impact the California blueberry industry.

CBC-funded Final Research Report

POSTHARVEST FUMIGATION: OPPOURTUNTIES & CHALLLENGES

Expanding export opportunities for California fresh blueberries

Spencer Walse

Project Summary

The overarching goal of this research is to develop postharvest treatments to facilitate the movement of California blueberries through trade and marketing channels. Particular attention is paid to the expansion into export markets. This research critically supports compliance with domestic quarantine regulations related to the protection and distribution of fresh blueberries, international regulations on ozone-depleting substances per the Montreal Protocol via the development of postharvest methyl bromide alternatives, and dealings with governments regarding insect-related phytosanitary issues that have the potential to serve as trade barriers. The balancing/melding of regulatory concerns with agriculture and industrial requirements to develop and utilize functional and economical postharvest treatments, including fumigation, requires specific analyses for each applied scenario where methyl bromide has to be replaced and/or contemporary infrastructure has to be retrofitted to accommodate safe usage of the alternative. Here we briefly outline efforts by CBC-funded researchers to develop postharvest fumigation as a tool that will enhance the global prominence of California blueberries.

With the ever-increasing demand in both domestic and international markets for food quality, safety, and security, there also comes the critical need to control horticultural pests in the safest and most economical ways possible. Whenever horticultural crops traverse political boundaries, pest-related trade barriers can ensue. Frequently, but not always, these barriers are mitigated with the aid of scientific contribution. The Crop Protection and Quality Research Unit (CPQRU) of the USDA-ARS San Joaquin Valley Agricultural Sciences Center (SJVASC) in Parlier, California, has a team of scientists dedicated toward this end, with particular attention given to postharvest pest control strategies that enhance the competitiveness of United States agriculture.

As a member of the CPQRU research team, chemist Dr. Spencer Walse leads a program focused on trade barrier issues, with the major goals of 1) the retention and expansion of domestic and/or international markets for US growers and 2) the protection of US growers from the agricultural, ecological, and economic threat posed by horticultural pests. With a research scope that encompasses a variety of key technical and regulatory issues, such as Maximum Residue Levels (MRL)[1], pesticide registrations, food safety, and IPM strategies, arguably the greatest effort is given toward the development of novel theories and treatments for postharvest insect pest control.

As would be expected, Dr. Walse teams with many in academia and industry to tackle postharvest insect control issues for the California blueberry industry. Dr's Adaskaveg (UCR), Xiao (USDA-ARS-SJVASC), and Smilanick (USDA-ARS retired) continue to provide invaluable collaborative expertise owing to their years of blueberry (and table grape) experience. Industry organizations, specifically the California Blueberry Commission and the United State Highbush Blueberry Council, provide key support to the coordinated research effort, as the scientific aspects of a project must meld with political, regulatory, and economic nuances.

Relative to treatments applied during production, whether that be GMO-plantings, conventional insecticide applications, or any IPM strategy for that matter, postharvest opportunities allow for greater synchronization of the treatment with the logistical and infrastructural constraints that funnel into the marketing channel. While efforts continue across the gamete of postharvest possibilities, which include cold-treatments, heat-treatments, irradiation, controlled atmosphere, fogging, etc., fumigation continues as an invaluable postharvest treatment option.

Postharvest fumigation is a critical element of the ~$18 billion per year California specialty crop industry, as it provides a biological safeguard against pests and, in many scenarios, is the only available tool for governments, regulators, and industry to guarantee pest-free security and food safety. One fumigant, methyl bromide, has dominated the postharvest applications in California and beyond. Methyl bromide quickly penetrates commodity loads and has, in general, non-discriminating efficacy against insect and microbiological pests (Bond, 1984). As such, methyl bromide has been used successfully for quarantine[2] and preshipment[3] (QPS) disinfestations over the last four decades; in fact, its routine use has left the specialty crop industry, producers and port facilities alike, with infrastructural capabilities that are almost exclusively geared toward postharvest chambers designed specifically for methyl bromide use.

There are many dynamics involved with the continued use of methyl bromide by the specialty crop industry as a whole, several of which are currently poignant to the California blueberry industry. Methyl bromide use is regulated via international legislation under the Montreal Protocol[4]. The Protocol (Article 2H) *recognizes that QPS methyl bromide is an important remaining use of this ozone-depleting substance that is not controlled*, a clear acknowledgment by the international community that methyl bromide is critically important and will continue as the "tool of first choice" due to its internationally accepted efficacy and regulatory status. However, (decision XI/13) urges *Parties to implement procedures to monitor the QPS uses of methyl bromide by commodity and* (decision VII/5) *urges Parties to refrain from using methyl bromide and to use non-ozone-depleting technologies.* This "urging of the Parties" away from QPS methyl bromide use creates a myriad of challenges for regulatory, agricultural, and industry entities with a stake in postharvest chamber fumigation, a technology that literally evolved around QPS methyl bromide use. The situation is further complicated by the fact that continued QPS uses are at the discretion of the importing nation per FAO standards (ISPM, 2007).

One of the key export markets targeted by California blueberries, Australia, is a nation with reciprocal, albeit limited, blueberry production and a GDP purchasing power ranked 19th in the world. The key insect pest of concern to Australia, as related to California and all other states, is the spotted wing drosophila (SWD). Since 2010, Australia has accepted postharvest methyl bromide fumigation as a means to control SWD in (listed in order of acceptance): table grapes, sweet cherries, raspberries, peaches & nectarines, plums, and apricots. From a technical perspective, the acceptance of efficacy data for fresh blueberries, which was funded by CBC and provided to APHIS in 2014, is nothing more than a regulatory formality. Yet, California (Washington and Oregon) blueberry growers continue to wait because Australia is requesting that market access be granted for the entire US, including fruit sourced from Eastern states where blueberry maggot (BBM) (*Rhagoletis mendax*) is a key concern. Using resource at UC Davis's Quarantine Research Facility as well as Michigan State University, Dr. Walse's team has nearly completed the research to establish a methyl bromide fumigation schedule to control BBM, which is likely to require parameters identical to those required for SWD control. The expectation is to submit the completed research for BBM to APHIS, for transmission to Australia by fall of 2019.

With respect to market access for California blueberries to Korea, it is difficult to rationalize the lack of progress from a technical perspective, meaning political and regulatory factors are driving this issue. Oregon blueberries have market access under a "systems approach", while California and Washington blueberries are sidelined. Adding to the frustration, the methyl bromide treatment for BBM will likely satisfy Korean quarantine requirements, thereby potentially opening market access for fresh blueberries from the Eastern states. Notably, Korea has been pushing to move away from methyl bromide use at its ports of arrival due to worker exposure issues, meaning the BBM treatment will have to be done stateside, pre-departure, causing Eastern shippers to 1) put fumigated fruit on the water for a ~14 day container voyage or 2) burden the expense of air freight. Those with knowledge of the impact on fruit quality of pre-departure methyl bromide treatments of Chilean fruit for European Grapevine Moth (EGVM) and/or Mediterranean fruit fly (Medfly) should understand the inherent risk of the former option.

The following paragraphs will summarize efforts made by the CPQRU research team, as well as seminal University of California and industry collaborators, toward the development of postharvest MB alternatives for the California blueberry industry.

Since the US government became a signature of the Montreal Protocol in 1988, researchers and industry, near and afar, have been diligently working – some would call it struggling mightily- to find technically and economically viable postharvest alternatives to methyl bromide. Foremost, the alternative must have a domestic food tolerance[5], which can cost a registrant a capital investment of greater than one million USD and take five years for USEPA to review, and not necessarily approve. Secondarily, the alternative must have MRLs in the target market, which essentially means the registration/approval process must repeat itself in the foreign regulatory realm.

Incomprehensible to most, or at least the author, only a single "stand-a-lone" postharvest methyl bromide alternative, phosphine, can currently be used to treat fresh fruit stateside, and currently the treatment of blueberries is not allowed on the phosphine label. However, this should change within a year, as a proposed inclusion of "all fresh fruit and vegetables" on the labels of the two formulations of cylinderized phosphine, Ecofume and Vaporphos, are currently being reviewed by the USEPA. Owing to the pioneering work of Dr. Fransiskus Horn in the late 1990's, phosphine is now used to treat fresh fruit at cold-storage temperature and MRLs of 10 ppb are established in nearly all key exports markets targeted by California blueberries, with those in Australia (and New Zealand) currently pending. MRLs of 10ppb, consistent with a "no detection" per international food standards of Codex Alimentarius, are used across the globe and are essentially a regulatory formality because they "acknowledge" a treatment that would otherwise be undetected during residue analysis. The rapid off-gassing of phosphine from fresh fruit, including blueberries, during the USEPA mandated 48-hour lag (under cold-storage) between fumigation aeration and consumption enables compliance with such a low food tolerance, with the chance of non-compliance in a foreign market being essentially nil. Moreover, the rapid off-gassing of phosphine during aeration minimizes worker exposure concerns, relative to methyl bromide which takes > 20-fold longer to off-gas from a given type of fruit. Another advantage of phosphine is that it generally enhances quality of fruit, as evidenced by a CBC-funded project began to thoroughly benchmark the quality of phosphine-treated blueberries relative to that treated with methyl bromide.

There are key features, however, that differentiate phosphine and methyl bromide. Whereas methyl bromide works on the timescale of 2 to 4 hours at treatment temperatures above 40°F, phosphine is typically used on the timescale of 12 to 72 hours at "cold-storage" temperatures spanning ca. 31 to 45°F. With respect to SWD, growers/packers should expect at treatment lasting 48 h at fruit temperature above 32°F. It will likely require 5 d under these conditions to control BBM, not a very attractive option for industry, so work continues to try to shorten the duration.

The necessity to treat for such a long duration, relative to that required for methyl bromide, requires compensatory scaling of fumigation structures so as to accommodate pack-house throughput requirements, particularly for larger export markets. Chile fresh fruit packers and shippers have overcome this logistical complication, primarily, by conducting phosphine fumigation in large controlled-atmosphere rooms or banks of modified reefer containers. Whether it be used as a stand-a-lone postharvest fumigation, or as a final mitigation step as part of a systems-approach to pest control, phosphine is an available tool for the California blueberry industry and the extent of its usage will depend on industry drivers and considerations.

With respect to the anti-fungal fumigant, sulfur dioxide, there is a full-court-press toward federal and state registration of both the cylinderized fumigant as well as sodium metabisulfite products (pads, liners, etc.), which slowly emit sulfur dioxide during storage and shipping. Essentailly, CBC and USHBC are pushing for the blueberry industry to have the same opportunities as the table grape industry, with respect to sulfur dioxide use. Registration of the cylinderized fumigant will allow users to quickly apply up to 10,000ppmv sulfur dioxide for 30 min to incoming fruit at pulp temperature greater than 60°F. Known as the "insect treatment" this application controls black widow spiders (if present), other surface pests, and considerably impacts SWD levels. In fact, when this fumigation is followed by 6 day of cold storage at 31.7°F, or alternatively 12 day storage at 33.7°F, levels of SWD control are achieved to meet the standards of Australia. Clearly, being able to use 10,000ppmv sulfur dioxide for 30 min, followed by a 6 d cold treatment, would be a great opportunity for the blueberry industry and would result in fruit of much higher quality relative to the use of methyl bromide. Two other scenarios for the cylinderized fumigant are being pursued. The first will hopefully allow 2,500ppmv sulfur dioxide to be applied via “total utilization” once a week for at least 5 consecutive weeks. The second will hopefully allow 400ppmv sulfur dioxide to be applied via “total utilization” thrice a week for at least 5 consecutive weeks. The blueberry industry has a significant amount of exploration ahead as it learns how to best optimize the use of sulfur dioxide, tailored to specific logistical needs and/or varieties.

With respect to the sodium metabisulfite products, Dr. Chang-lin Xaio and Dr. David Obenland of CPQRU have studied evaluated the effectiveness of pads, liners, and bags alone or in combination with modified atmosphere packaging bags (MAP) for control of gray mold and other diseases and for maintenance of fruit quality. Dual-stage SO_2-emitting pads (SO_2 is initially released up to 10 ppm and then declined and stabilized at a low concentration), slow-release SO_2-emitting pads (SO_2 is released at a low and constant concentration), or MAP bags significantly reduced fruit rots during cold storage compared to nontreated controls. The dual-stage SO_2 pad in combination with MAP or slow-release SO_2 pad in combination with MAP provided even better control, but the dual-stage SO_2 pad can cause bleaching on blueberry fruit due to SO_2 injuries. Results indicate that the combination of slow-release SO_2-emitting pad and a MAP bag is a promising method for control of fruit rots while maintaining blueberry fruit quality during storage. Current efforts are conducted in close collaboration with manufacturers to design use-patterns and labels for registration of sulfur dioxide fumigation as well as SO_2 -emitting sodium metabilsulfite products (liners, pads, bags) for blueberries.

Two other alternative fumigants, ethyl formate and propylene oxide, are currently being investigated by the CPQRU research team for insecticidal efficacy, residue characteristics, and impacts on fruit quality. While it is unlikely that ethyl formate and propylene oxide will provide control of SWD and BBM at doses that do not harm fruit, following fumigations lasting less than 2 hours, interestingly, both ethyl formate and propylene oxide are highly effective against external feeding insects, including mites, psyllid, and thrips. Stay tuned for research outcomes regarding technical aspects of these methyl bromide alternatives as well as feedback from the regulatory front as we push to establish food tolerances and labels for the blueberry industry.

If any blueberry growers, packers, and shippers wish to learn more about postharvest treatments, including fumigation, please reach out to the CPQRU team. We are always willing to conduct fumigations in Parlier, California so that folks have an opportunity to observe the treatment and evaluate fruit quality on their own terms/criterion – drop the fruit off, we will treat it, and then return the fruit for evaluation.

[1]**Maximum Residue Levels (MRL):** the highest level of a pesticide residue that is legally tolerated in or on food or feed when pesticides are applied correctly per label instructions (Good Agricultural Practice).

[2]**Quarantine**: treatments to prevent the introduction, establishment and/or spread of quarantine pests (including diseases), or to ensure their official control, where:(i) Official control is that performed by, or authorized by, a national plant, animal or environmental protection or health authority;(ii) Quarantine pests are pests of potential importance to the areas endangered thereby and not yet present there, or present but not widely distributed and being officially controlled;

[3]**Preshipment**: treatments applied directly preceding and in relation to export, to meet the phytosanitary or sanitary requirements of the importing country or existing phytosanitary or sanitary requirements of the exporting country.

[4]**Montreal Protocol:** International treaty designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion. It has been ratified by 197 parties, which includes 196 states and the European Union, making it the first universally ratified treaty in United Nations history.

[5]**Food tolerance:** Limits on the amount of pesticides that may remain in or on foods marketed in the USA (referred to as MRLs in many other countries); set by the USEPA and enforced by USDA (just meat & poultry) and FDA (other foods).

References.

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International Standards for Phytosanitary Measures (ISPM) No. 28. 2007. *Phytosanitary Treatments for Regulated Pests*. Pp. 3- 11.m http://www.furs.si/law/FAO/ZVR/ENG/184208_ISPM28_2007_E.pdf

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Spencer Walse, Ph.D., is a Research Chemist at the United States Department of Agriculture, Agricultural Research Service, San Joaquin Valley Agricultural Sciences Center as well as an Adjunct Professor in the Environmental Toxicology Department at the University of California, Davis.

For additional information, please contact spencer.walse@ars.usda.gov

Spotted Wing Drosophila 2018 Final Report –Akbari and Hay

Project Title: **Engineered transgenic *Drosophila suzukii* for wild population suppression and eradication: production, performance assessment, and effective wild releases.**

Collaborating PIs:
Omar S. Akbari, University of California, San Diego
Bruce A. Hay, California Institute of Technology

ORIGINAL OBJECTIVES

Drosophila suzukii is a major invasive pest of ripening small fruit including raspberries, blueberries, strawberries, and cherries [1,2]. It has caused significant worldwide economic losses including significant damage in the berry- and cherry-growing industries of western North America [2–5]. Achieving effective control of *D. suzukii* has been difficult in a number of crop systems including cherries [6,7], and control measures have largely relied on prophylactic application of expensive broad spectrum insecticides [6–8]. This is problematic, as the repeated use of broad-spectrum insecticides has led to disruption of integrated pest management systems developed for crops such as cherries and berries, and has had a serious impact on beneficial arthropods, resulting, for example, in an increased use of miticides [4]. Additionally, broad use of insecticides makes it inevitable that resistance will become a major problem in the foreseeable future [8] (in fact, the first incidence of spinosad resistance in the US has just been reported in California [13]). Finally, broad insecticide use increases the risk of residues on fruits [8], and arouses public concern [6]. However, there are no effective alternatives to managing *D. suzukii* infestation, and it is likely that, unless more effective control measures are developed, this pest will continue to spread [8].

An alternative, highly promising approach that could complement existing control methods is genetic pest management [9], which includes strategies such as gene drive [10,11] and transgenic-based sterile insect technique (SIT) [12,13]. In particular, engineered *D. suzukii* gene drive strains can be utilized to spread desirable genes (e.g., susceptibility to a novel bio-friendly pesticide) throughout, or to entirely suppress/eradicate, wild *D. suzukii* populations. Such an approach is catalytic, with release of only modest numbers of engineered insects required to spread desirable genes or achieve population suppression. Additionally, since such a system relies on only a few releases of transgenic insects to do the all of the work on an ongoing basis, it is cheap as compared to the use of insecticides, which need to be applied regularly. Finally, a major appeal of this approach is that it is environmentally friendly and entirely insect-specific, and would have no effect on crops or on beneficial organisms.

Our objective over the last year, therefore, was to make progress towards engineering gene drive systems in *D. suzukii*. Specifically, out of the multiple types of gene drive systems that can be utilized in a genetic pest management program [11,14], we decided to focus our efforts on developing *Medea* and Cas9-mediated systems. Our goals were to evaluate the feasibility of engineering each strategy in *D. suzukii*, and to take concrete steps towards developing a product (a genetically modified *D. suzukii*) that can be mass-reared and deployed into the wild to catalytically suppress, and completely eliminate, the wild populations of this significant pest.

SIGNIFICANT FINDINGS

I. Objective A - Development of CRISPR/Cas9-based drive systems in *D. suzukii*
   A. Achieved an efficient means of transgenesis (required to test any gene drive components)
   B. Developed and characterized multiple Cas9 transgenes in *D. suzukii* that are highly functional and enable efficient Cas9-mediated mutagenesis
   C. Developed several ways to efficiently express gRNAs from the *D. suzukii* genome
   D. Developed/optimized several components needed to build Y-gene drive
      1. Identified *D. suzukii* X and Y chromosome regions

2. Identified putative X chromosome specific target sites
3. Efficiently engineered the Y chromosome of flies

E. Developed/optimized several components needed to build Cas9-based suppression gene drive
1. Identified promising suppression drive candidate target genes
2. Identified *D. suzukii* homologues of target genes and selected suitable gRNA target sites within these genes
3. Designed gRNA-expressing transgenes to test ability to target these genes
4. Built a proof of principle Cas9-based homing system in the *white* gene to test its ability to self-replicate

II. <u>Objective B - Development of a *D. suzukii Medea*-based drive system</u>

A. Finished characterizing and testing previously developed *D. suzukii Medea* drive system
1. Characterized resistance to this drive system, which could hinder the spread of such a drive

B. Developed a modified version of this same system that should obviate the observed resistance
1. Currently testing this system; preliminary evidence suggests that it does, as expected, function better that the original *Medea*

C. Developed a second-generation "reversal" *Medea* system that should be more robust in the face of genetic diversity in general and could be used to replace the original *Medea* in case a recall is necessary
1. Currently testing this system

D. Identified several promising putative cargo genes that could be spread with the *Medea* gene drive to cause population suppression
1. Currently testing these in *D. melanogaster* as proof of principle

RESULTS & DISCUSSION

<u>(A) Development of CRISPR/Cas9-based drive systems</u>

<u>Summary</u>

CRISPR/Cas9 technology has great applicability to the development of genetic pest management approaches, and can be used to build various gene drives - including Y-chromosome drive and Cas9-mediated homing-based drive - that can be employed to suppress and eliminate pest populations. We have made significant progress in developing the tools needed to engineer both of these types of gene drives in *D. suzukii*. Specifically, we have developed and characterized multiple Cas9 transgenes in *D. suzukii* that are highly functional and enable efficient Cas9-mediated mutagenesis in this pest. We have also developed several ways to efficiently express gRNAs from the *D. suzukii* genome. Together, these tools enable efficient CRISPR/Cas9-based manipulations of the *D. suzukii* genome, and provide the basis for building Cas9-based gene drives. Furthermore, we have developed/optimized several components needed to build Y-gene drive, including identifying *D. suzukii* X and Y chromosome regions, identifying putative X chromosome specific target sites, and efficiently engineering the Y chromosome of flies. Additionally, we have also taken steps towards engineering Cas9-based suppression gene drive, including: identifying promising candidate genes to be targeted by this drive; finding *D. suzukii* homologues of, and selected suitable gRNA target sites within, these genes; designing gRNA-expressing transgenes to test our ability to target these genes; and building a proof of principle Cas9-based homing system in the white gene to test its ability to self-replicate. We can now begin putting these components together to generate functional suppression gene drives in *D.suzukii*.

<u>Background</u>

The arrival of CRISPR technologies heralded a new era for traditional genome manipulation and site-specific transgenesis [15,16], and for advanced engineering of target genomes including the construction of gene drives [14,17]. Out of all the types of gene drives that have been proposed, drives based on the

CRISPR/Cas9 gene-editing system may be the simplest to build (especially given CRISPR's functionality in many insects [18–26]) and the most effective [11]. Most CRISPR technologies used in insects utilize a simplified two-component system consisting of a *S. pyogenes* Cas9 endonuclease (SpCas9) and a single chimeric guide RNA (gRNA) [27] that can generate DNA double-strand breaks (DSB) in a location of one's choosing. These breaks can them be repaired either randomly (via non-homologous end-joining, NHEJ) or based off a template (via homology-directed repair, HDR) [27,28]. The functionalities of CRISPR/Cas9 systems can be exploited to bring about gene drive-based population suppression.

For example, distortion of the sex ratio in favor of males can lead to a gradual population reduction and eventual elimination of a target population [29–32], and natural so-called meiotic driving Y-chromosomes have been described [33–35]. A system for sex-ratio distortion can also be engineered by designing CRISPR-based transgenes that target the X-chromosome during spermatogenesis [36,37](Figure 1). This Y-gene drive approach would depend on the destruction of X-bearing sperm to produce males that only give rise to male progeny [14,38], and would require the ability to meiotically express an X-chromosome targeting element from the Y-chromosome [36,39]. Importantly, CRISPR/Cas9 technology could straightforwardly be utilized to engineer Y-gene drive elements by designing gRNAs that target only the X chromosome [36,37]. Such a system has already been developed in one species of mosquito [36,40,41], and should be portable to *D. suzukii*.

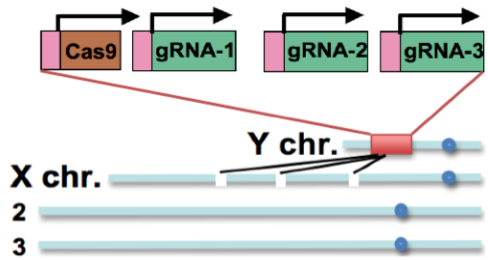

Fig. 1

Another way CRISPR/Cas9 can be utilized to bring about population suppression is via Cas9-mediated homing-based gene drive [14]. This concept is based on the idea of using homing endonuclease genes (HEGs) to manipulate populations [42]. These genes are extraordinarily selfish, and this property can be exploited for both population suppression and replacement. HEGs have the ability to "cheat" during meiosis by converting their corresponding allele on the opposite chromosome into an exact copy of themselves, by encoding a sequence-specific endonuclease that severs and disrupts their competing chromosomal allele, which can force the call to use the HEG as a template for homology-directed repair (HDR), resulting in the HEG copying itself (i.e., homing) into its competing allele. If the latter repair option occurs in the germline, or early embryo, then the proportion of offspring that receive the HEG will be above that expected with normal Mendelian transmission (i.e., 50%), allowing for rapid invasion of the HEG into a target population [43]. A HEG can be used to spread a payload gene (replacement drive) or for population suppression and possibly eradication by homing into a target gene, the disruption of which leads to recessive lethality or sterility (Figure 2). In such a suppression approach, homing must be confined to the germline during gamete formation, leading to sterility/non-viability only in homozygotes that receive the HEG allele from both parents. Consequently the HEG can rapidly spread, and once a large fraction of the population is heterozygous, it can cause a population crash as heterozygote pairings will produce sterile/non-viable offspring.

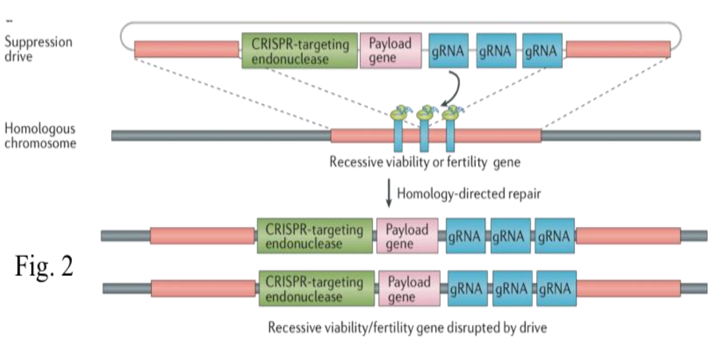

Fig. 2

Although several proof-of-principle studies have shown the utility of HEGs as gene drives prior to the advent of CRISPR/Cas9 (e.g., [44]), this powerful system is enabling the efficient design of homing-based drive systems in many contexts [17]. Several replacement Cas9-mediated homing-based gene drives have been developed [18,45,46]; additionally, several Cas9-based suppression drive systems have recently been engineered in fruit flies [47,48] and one species of mosquito [20,49], and should also be possible to transfer to *D. suzukii*. However, neither this approach nor Y-gene drive have been developed in this pest species.

Results and Future Directions

Efficient Transgenesis in *D. suzukii*

In order to engineer any type of gene drive system in *D. suzukii*, we first have to be able to efficiently generate transgenic flies. Although transgenesis in *D. suzukii* has been previously established [50], it is not very efficient [51], and we had previously struggled with obtaining *D. suzukii* transgenic fly lines. However, a recent work [52] described the generation of a "jumpstarter" *D. suzukii* strain that carries the *transposase* gene necessary for *piggyBac* transposition, and reported that performing germline transformation in this strain dramatically increased transgenesis rates (in some cases 40- to nearly 60-fold [52]). Since increased rates of transgenesis would help us accelerate our gene drive development efforts, this past year we obtained the USDA/APHIS permits necessary to acquire this transgenic strain from the researchers that developed it, have expanded the obtained stocks into a large colony, and are carrying out all microinjections for transgenesis into this strain. This has been greatly helpful, as we are now able to obtain transgenic lines with much greater efficiency.

Development of Cas9 Tools in *D. suzukii*

The development of both Y-gene drive and Cas9-mediated suppression drive in *D. suzukii* requires functional CRISPR/Cas9 tools in this fly. Although Cas9-mediated genome editing had been previously demonstrated in *D. suzukii* [53], it was carried out by microinjection of gRNAs and Cas9 protein into embryos. Conversely, the building of a gene drive requires a germline source of Cas9 and gRNAs driven by an effective promoter, typically a PolIII promoter such as U6.

Leveraging our experience in designing and optimizing CRISPR/Cas9 tools in *D. melanogaster*, we have generated both of these components. Specifically, we have generated four distinct functional transgenic Cas9 lines, where expression of Cas9 is driven by either strong female germline specific promoters (*BicC* and *Dhd*) or by male and female germline specific promoters (*vasa* and *nanos*) that have been previously validated in *D. melanogaster* [12,46]. We have tested these Cas9 lines, and have shown that all four work, with up to 100% mutagenesis efficiency (for *vasa*-Cas9). We have also generated several functional gRNA-expressing transgenes by targeting the *white* gene, which gives flies a red eye color, as a proof of principle. Specifically, after several failed attempts, we have demonstrated that a genomically encoded, PolIII U6:3 promoter-driven gRNA targeting *white* produces up to 100% mutated (white and mosaic-eyed) progeny when crossed to a Cas9 expressing line (Figure 3). We have also shown that a genomically encoded tRNA-gRNA expression cassette [54], driven by a PolII germline specific promoter, also functions to produce mutated progeny (albeit at a more modest frequency of ~15-30%).

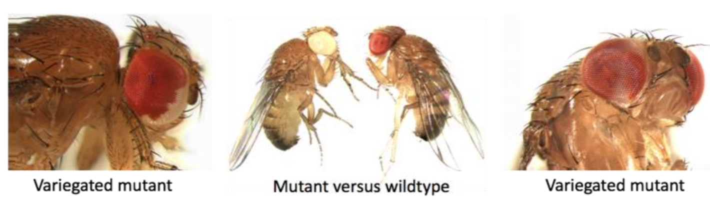

Fig. 3

The development of these tools lays the foundation for the ability to engineer Cas9-based gene drives in *D. suzukii*.

Engineering a Y-gene Drive System

Assuming that efficient CRISPR/Cas9 tools are available, the ability to build a Y-gene drive requires three further components: the ability to identify X and Y chromosomes in *D. suzukii*; the ability to insert large transgenes on the Y-chromosome; and the ability to target and cut sequences only present on the X-chromosome.

Identifying, and inserting genes on, the Y chromosome in D. suzukii

The current genome annotation of *D. suzukii* (http://spottedwingflybase.org) is divided into over 29, 000 contigs (independent fragments that have not been brought together to make a clear linear sequence map of each chromosome), and it is not entirely clear which of these contigs comes from the *D. suzukii* Y and X chromosomes. Therefore, we have used a bioinformatic approach to try to identify fragments of these chromosomes. To do this, we took the entire *D. melanogaster* Y chromosome sequence and carried out a search for related sequences (a BLAST homology search) among the *D. suzukii* contigs; essentially, we looked for regions of *D. suzukii* that were nearly identical to those from the melanogaster Y chromosome, as these are likely to represent *D. suzukii* Y chromosome sequence. We identified a total of 134 contigs that had extremely high homology (E-value = 0) to the *D. melanogaster* Y chromosome. Given this high homology, we are confident that these contigs are pieces of the *D. suzukii* Y chromosome. From this data we have identified several regions of the putative *D. suzukii* Y chromosome that should be ideal locations for integrating an X chromosome targeting Cas9/gRNA cassette (outside of any known transcribed regions, in unique, non-repetitive DNA).

In order to assay whether we could use CRISPR/Cas9 to dock transgenes on the Y chromosome, we first set out to develop a CRISPR/Cas9-based technique for site-specific engineering of the *D. melanogaster* Y chromosome as a proof of principle [55], as it is much easier and faster to test and troubleshoot components in this species before porting them to *D. suzukii*. To do this, we engineered a vector comprising a fluorescent marker (tdTomato) driven by the eye-specific 3xP3 promoter and flanked by the gypsy and CTCF insulators, with unique restriction sites upstream and downstream for cloning specific homology arms (Figure 4). We then selected ten distinct intergenic regions spanning the Y chromosome for targeting, identified a suitable sgRNA target site in each region, and cloned in homology arms, corresponding to ~800-1,000 base pairs of sequence 5' and 3' of each selected target site, upstream and downstream of the insulator-flanked 3xP3-tdTomato element to generate ten unique Y chromosome targeting transgenes. Each transgene was then injected, along with the appropriate in vitro transcribed sgRNA and Cas9 protein, into a transgenic line expressing a germline source of Cas9 using standard procedures, and G1 progeny were screened for presence of the transgene marker. Two of the injected transgenes inserted in the correct positions on the Y chromosome, demonstrating that we can use the above approach to insert, and detect expression from, a fluorescently marked transgenic cassette at specific locations on the Y-chromosome in *D. melanogaster* using CRISPR/Cas9-mediated HDR.

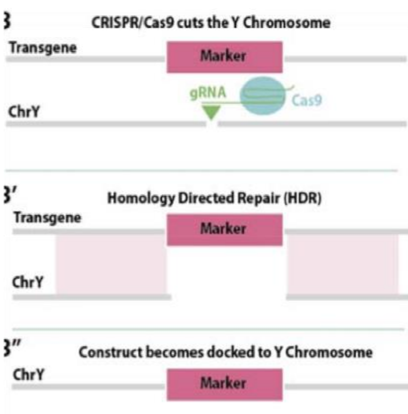

Fig. 4

We are now testing whether we can insert, and detect expression from, Cas9-containing transgenes at these same Y chromosome locations, as we will need to be able to express Cas9 cassettes from the Y in order for the Y gene drive approach to work. Once these experiments are complete, we plan to port this approach to *D. suzukii*.

Identifying and cutting the X chromosome in D. suzukii

We performed a similar bioinformatic analysis to the one described above identify the X chromosome of *D. suzukii*, and identified 388 contigs from *D. suzukii* as being X-linked. Then, to identify potential gRNA sequences specific to the *D. suzukii* X chromosome, and present in multiple copies, we first developed a program to predict all possible Cas9 cleavage sites on the X-chromosome by searching for the PAM motif (XGG in the target sequence N(21)XGG). Once potential X-chromosome cleavage sites were identified, they were aligned to the rest of the genome (all the other non-X contigs) and those that showed a sequence match to these contigs were eliminated. The final output of this program was a conservative list of X chromosome specific Cas9 cleavage sites.

From all of this, we conservatively predicted several potential target sequences repeated exclusively on the X chromosome in up to ten locations, making them ideal for the development of guide RNAs to cleave the *D. suzukii* X chromosome. However, our initial attempts at testing these gRNAs for their ability to cut the X did not succeed because, as discussed above, our initial gRNA-expression configuration were not functional. However, now that we have a highly functional gRNA expression configuration, we can proceed to clone X chromosome-targeting gRNAs into our gRNA expression cassettes and test them.

Engineering a Cas9-mediated Suppression Drive System

To engineer a Cas9-mediated suppression homing drive, we need to introduce the coding sequence for Cas9 and gRNA into the genomic site targeted by the Cas9/gRNAs [11] to generate a self-replicating transgene that could continuously mutate a target gene every generation and/or carry a transgene into the population. This self-replicating (i.e., homing) Cas9-based transgene would need to be placed within a gene necessary for female fertility, so that eventually all of the females in a target population would become sterile and the population would collapse [49].

As described above, we now have working Cas9 and gRNA transgenes that we can utilize as the basis for such a gene drive. After analyzing recent efforts to develop such suppression drive systems in fruit flies [47,48] and mosquitoes [49], we have also identified several promising candidate target genes, including *dsx*, *tra*, *sxl*, and *zpg*, which are conserved in *D. suzukii*. After analyzing the sequences of the *D. suzukii* homologues of these genes to find regions that are highly conserved and thus unlikely to contain sequence variation, we have selected two gRNA target sites within each gene, and have engineered separate U6-driven gRNA transgenes targeting each gene to test whether the selected gRNA sequences will work to efficiently cut the selected targets. (We are currently working on obtaining transgenic lines for these transgenes.) After we verify that the gRNAs work, we will proceed to construct full Cas9-based suppression drive cassettes targeting the most promising candidates (based on gRNA function). In parallel, we are also testing a split Cas9-based gene drive cassette [56] targeting the *white* eye color gene as a proof of principle, to determine whether we can: a). dock transgenes in a site-specific location using CRISPR/Cas9 in *D. suzukii*; and b). observe the efficiency of self-replication/homing of this Cas9-based transgene in *D. suzukii*.

(B) Development of a *D. suzukii Medea*-based drive system

Summary

Previously, we had developed the first *D. suzukii* functional replacement gene drive system termed *Medea*, had rigorously tested it in laboratory cage populations, and had characterized it in different genetic backgrounds to determine effectiveness and fecundity (our results on this project were published in *PNAS* this year [57]). We found that this first-generation *Medea* system was capable of biasing Mendelian inheritance rates with up to 100% efficiency and could maintain itself at high frequencies in a wild population; however, drive resistance, resulting from naturally occurring genetic variation and associated fitness costs, was present and could hinder the spread of such a drive. Therefore, since mathematical modeling indicated that our *Medea* drive system could spread to fixation if either its fitness costs or toxin resistance were reduced [57], we have developed a modified version of this same system that should obviate the specific resistance that we observed, and have preliminary evidence to suggest that it does, in fact, function better that the original *Medea* we tested. We have also developed a second-generation *Medea* system in *D. suzukii* that should be more robust in the face of genetic diversity in general and could be used to replace the original *Medea* in case a recall is necessary. Finally, we have identified several promising putative cargo genes that could be spread with the *Medea* gene drive to cause population suppression, and are moving forward with testing them in *D. suzukii*.

Background

Medea was first discovered in the flour beetle [58], and multiple versions were later reverse engineered from scratch and shown to act as robust gene drives in the laboratory fruit fly, Drosophila melanogaster [59,60]. Such engineered *Medea* systems rely on a *Medea* element consisting of a toxin-antidote combination (Figure 5). The toxin consists of a miRNA that is expressed during oogenesis in *Medea*-bearing females, disrupting an embryonic essential gene. A linked antidote is expressed early during embryogenesis and consists of a recoded version of the target gene that is resistant to the miRNA. This combination results in the survival of half of the embryos originating from a *Medea*-bearing heterozygous female, as those that do not inherit the *Medea* element perish. If a heterozygous *Medea* female has mated with a heterozygous *Medea* male, the antidote from the male will also take effect in the embryo, resulting in 3/4 of the embryos surviving. Therefore, *Medea* will rapidly spread through a population, carrying any linked genes with it.

In the case of *D. suzukii*, since elimination of the pest population is ultimately the goal, an engineered *Medea* system could spread a gene proffering susceptibility to a particular pesticide, or a conditional lethal gene that would be activated by some substance or environmental cue such as high temperature or diapause - a state that allows insects survive periods of adverse conditions such as cold [61]. For example, a *Medea* element can be used to spread a gene conferring sensitivity to a particular chemical that is normally innocuous, rendering such a chemical capable of being used as an environmentally-friendly, species-specific pesticide. Trigger-inducible transcription control elements – ones that turn on expression in the presence of a chemical such as tetracycline or vanillic acid [62,63] – can be engineered to drive expression of an insect-specific toxin (e.g., [64]). A *Medea* element can also be used to spread a gene under the control of a diapause-induced promoter that will splice to produce a toxin in females only, so that, upon the onset of the diapause-inducing environmental cue, all of the females will perish, causing a population crash [59]. Furthermore, a *Medea* element can be utilized to spread a thermally activated TRPA1 cation channel [65] that, upon exposure to a specific threshold temperature, renders flies paralyzed or dead. However, although transgenesis of *D. suzukii* has been established [50], no effective suppression gene drive systems in this major pest have yet been engineered.

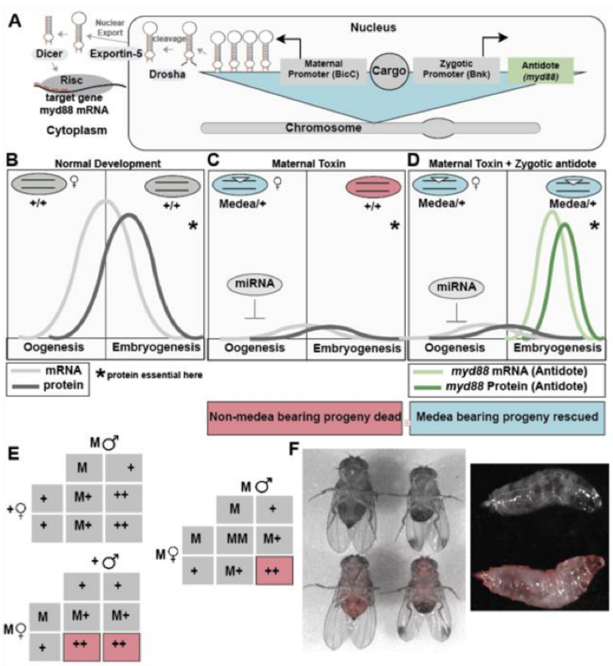

Fig. 5

Results and Future Directions

Generation of Synthetic *Medea* Gene Drive

To create a synthetic *Medea* gene drive in *D. suzukii*, we engineered a *piggyBac* vector comprising a miRNA toxin coupled with a toxin-resistant antidote, inspired by the architectures used to generate previous *Medea* systems in *D. melanogaster* [66,67]. We designed synthetic miRNAs to target *D. suzukii* myd88, a highly conserved gene shown to be maternally deposited and required for dorsal-ventral patterning in the early embryo in *D. melanogaster* [68]. We used the predicted *D. suzukii* female germline-specific bicoid (BicC) promoter to drive expression of a “toxin” consisting of a polycistronic array of four synthetic microRNAs (miRNAs) each designed to target the 5’ untranslated region (UTR) of *D. suzukii* myd88 (Figure 5). Importantly, to ensure these miRNAs could target the desired sequence, we performed genomic DNA sequencing of the myd88 5’UTR target region in our reference *D. suzukii* strain (collected from Corvallis, Oregon) and designed the miRNAs against this sequence. This *Medea* drive also contained an “antidote” consisting of the *D. suzukii* myd88 coding region, insensitive to the miRNAs as it did not contain the miRNA-targeted 5’UTR, driven by the predicted *D. suzukii* early embryo-specific bottleneck (bnk) promoter, and two separate transformation markers – eGFP driven by the eye-specific 3xP3 promoter [69], and dsRed driven by the ubiquitous hr5-IE1 promoter [70].

Characterization of *Medea* Genetic Behavior

Following microinjection of the *Medea* transgene into *D. suzukii* embryos, a single G_1 transformant male was recovered, as identified by ubiquitous hr5-IE1 driven expression of dsRed (Figure 5), and weak eye-specific 3xP3-driven eGFP. When outcrossed to several wildtype (non-*Medea* bearing; +/+) females, this male produced roughly ~50% *Medea*-bearing and ~50% wildtype offspring, as would be expected from standard Mendelian segregation without biased inheritance. Resulting heterozygous G_2 *Medea*-bearing progeny were individually outcrossed to wildtype individuals of the opposite sex to determine inheritance patterns, and these individual outcrosses were continued for six generations (Table 1). Remarkably, until the G_5 generation, all heterozygous *Medea*/+ mothers (n = 91) produced 100% *Medea*-bearing progeny (n = 1028), while heterozygous *Medea*/+ fathers (n = 16) produced ~50% *Medea*-bearing progeny (n = 268). While the majority of heterozygous *Medea*/+ G_5 (23/31) and G_6 (16/25) generation females also produced 100% *Medea*-bearing progeny, some heterozygous G_5 (8/31), and G_6 (9/25) females unexpectedly produced a small yet notable number (52/1219) of wildtype offspring. Although the exact reason for the difference is unclear, later analysis suggested that resistance to the miRNA toxin might explain this unexpected observation. Notwithstanding, individually these G_5 and G_6 heterozygous *Medea*/+ females displayed significantly biased biased inheritance rates ranging from 76%-96%, with an average rate of 86.4%. Overall, in six generations of individual female outcrosses, the percentage of *Medea*-bearing progeny borne by single heterozygous *Medea*/+ mothers (n = 147) was 97.7% (2195/2247) as opposed to the 50% that would be expected with standard Mendelian segregation, indicating that the *Medea* drive is extremely functional at biasing inheritance.

To further characterize the genetics behind the highly biased inheritance patterns described above, additional crosses between individuals of various *Medea* genotypes were performed, and confirmed that *Medea* exhibits maternal-effect lethality and zygotic rescue. For example, matings between heterozygous *Medea*/+ mothers and wildtype fathers resulted in 55.63±0.76% total embryo survival with 94.20±1.33% of the progeny being *Medea*-bearing, while matings between heterozygous *Medea/*+ mothers and heterozygous *Medea/*+ fathers yielded 79.11±3.95% total embryo survival with 94.12±0.67% of the progeny being *Medea*-bearing. The higher-than-expected embryo survival is consistent with the observation that not all heterozygous *Medea*/+ mothers give rise to 100% *Medea*-bearing progeny, indicating that not all wildtype progeny from a heterozygous *Medea*/+ mother perish.

<u>*Medea* Functionality in Geographically Distinct Populations</u>

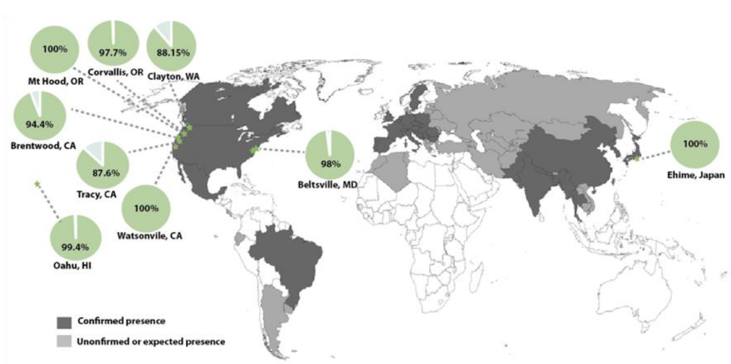

Fig. 6

To assess whether the *D. suzukii Medea* could function in geographically distinct populations that possibly harbor genetic variability in regions that canonically have less conservation such as the 5'UTR, heterozygous *Medea*/+ flies were tested in eight additional *D. suzukii* strain backgrounds. These strains were collected from various locations around the world, including: Mt. Hood, OR; Clayton, WA; Brentwood, CA; Tracy, CA; Watsonville, CA; Oahu, HI; Beltsville, MD; and Ehime, Japan. Interestingly, for 3/8 strains, the *Medea* inheritance rate from heterozygous *Medea*/+ mothers was 100%, while from 5/9 strains the inheritance rate ranged from 87.6% to 99.4%, with an overall transmission rate of 94.2% (Figure 6). These results strongly demonstrate that the *Medea* drive described here can dominantly bias transmission in diverse *D. suzukii* populations.

<u>Long Term Population Cage Experiments</u>

The above observations suggested that *D. suzukii Medea* should be able to drive robust population replacement. To test this prediction, we performed several long term multi-generational population cage experiments specifically challenging the *Medea* drive with a wildtype strain that harbored pre-existing resistance (Corvallis, OR). We set up these population cage studies after maintaining this population for approximately ten generations, we mated *Medea*-bearing fathers to wildtype Corvallis, OR, strain mothers at three distinct introduction (G_0) frequencies: low frequency (25 heterozygous *Medea*/+ and 25 wildtype +/+ males mated to 50 wildtype +/+ virgins, *Medea* allele frequency of ~12.5% and genotype frequency of ~25%); medium frequency (50 heterozygous *Medea*/+ males mated to 50 wildtype +/+ virgins, *Medea* allele frequency of ~25% and genotype frequency of ~50%); and high frequency (50 homozygous *Medea*/*Medea* males mated to 50 wildtype +/+ virgins, *Medea* allele frequency of ~50% and genotype frequency of ~50%). These experiments were conducted in separate bottles in biological triplicate for the low and medium threshold and quadruplicate for the high threshold drives, producing ten distinct populations with G_1 *Medea* allele frequencies ranging from ~12.5-50% and genotype frequencies ranging from ~25-100%. Altogether, these population cage experiments were followed for 9 generations (for lower allele frequency populations, as the *Medea* allele disappeared from the population by that time) or 19 generations (for higher allele frequency populations), counting the number of *Medea*-bearing adults each generation to determine the genotype frequency, as described previously [60,67]. Interestingly, the observed changes in *Medea* frequency over time indicated that, for release proportions (defined as the genotype frequency in the G_1 population) of 50% or smaller, the *D. suzukii Medea* drive was unable to drive into the wildtype population, likely because of selected drive resistance combined with high fitness costs outweighing the effect of drive. However, at higher release proportions of >90%, similar to classical chromosomal rearrangement thresholds [71], the drive largely compensated for the fitness cost, allowing the gene drive to remain in the population at high frequencies for the duration of the experiment (19 generations). Although unintended, the self-limiting dynamics of the generated *Medea* system may be useful in achieving a transient population transformation of the type associated with other proposed gene drives (e.g.,[72]).

Mathematical Modeling

To characterize the population dynamics observed in the above cage experiments, we fitted a mathematical model to the observed data in which the *Medea* drive had an associated fitness cost in heterozygotes and homozygotes and there was a *Medea*-resistant allele present in the population that reduced toxin efficiency. For the fitted model, the *Medea* drive was estimated to have a toxin efficiency of 93% in individuals homozygous for the resistant allele (95% credible interval (CrI): 90-95%) and was assumed to have a toxin efficiency of 100% in individuals lacking the resistant allele. The *Medea* drive was estimated to confer a large fitness cost on its host - 28% in heterozygotes (95% CrI: 27-30%) and 65% in homozygotes (95% CrI: 62-67%) - and the resistant allele was estimated to have an initial allele frequency of 78% in the population (95% CrI: 57-97%).

Predictive mathematical modeling based on these parameter estimates suggests that the *Medea* drive would spread to fixation in the absence of toxin resistance if released above a threshold frequency of 79%. Spread to fixation would also be expected if the fitness costs of the generated *Medea* drive were halved, even if all individuals in the population were homozygous for the *Medea*-resistant allele, provided the drive was released above a threshold frequency of ~25-27%. Consistent with the experimental results, a *Medea* drive with a large fitness cost in a *Medea*-resistant population is expected to be maintained at high frequencies through its drive; however, its eventual elimination is inevitable unless supplemental releases are carried out. However, for high release frequencies (90-95%), the drive may be maintained at high frequencies (>75%) for ~20 generations, which likely exceeds the duration required for agricultural impact.

Improved *Medea* Construct and Reversal *Medea*

Given our observations regarding resistance and its effect on *Medea* function, we set out to engineer improved *Medea* systems that could reduce the chances of resistance acting as an impediment to spread. Specifically, we performed some sequencing-based characterization of naturally occurring genetic variation in various geographically distinct target populations to help guide selection of target sites that are well conserved across all populations in which the drive is intended to function. We then designed a modified version of the original *Medea* system that targeted different, conserved sequences (still in the 5'UTR of the *myd88* target gene), reasoning that such a *Medea* element should function very similarly to the original element but not be impeded by the resistance we previously observed. We have obtained transgenic lines for this improved *Medea* element, and preliminary data indicates that it works better than the original *Medea*, producing 100% inheritance bias. We will continue rigorously testing this second-generation *Medea* element in the coming year.

Additionally, we hypothesized that to reduce resistance, miRNA target site selection could be limited to the coding DNA sequence regions of a genome, which tend to be strongly conserved, as opposed to regions such as the 5'UTR, which canonically have higher tolerance for sequence variation. We have therefore also developed a second-generation *Medea* system in *D. suzukii* that should be more robust in the face of genetic diversity in general (because it targets coding DNA regions as opposed to the 5'UTR) and could be used to replace the original *Medea* in case a recall is necessary. Specifically, to reduce risk and mitigate the spread of the *D. suzukii Medea* system into wild populations, it is important to develop a reversal Medea (RM) system and demonstrate that it can function as predicted. Reversing the drive of a *Medea* system has been theorized; however, it has never been experimentally demonstrated. Therefore, this should be of high impact and relevance when it comes to regulators assessing the risk associated with gene drives. We have finished designing and building a Reversal *Medea* system capable of spreading on its own and of replacing the first *Medea* described above, and are in the process of obtaining transgenic *D. suzukii* individuals containing this *Medea* and of rigorously characterizing this system.

Identification of Putative "Cargo" Genes

For *D. suzukii*, elimination of the pest populations is ultimately the goal. An engineered *Medea* system could achieve this by spreading a "cargo"gene proffering susceptibility to a particular pesticide, or a conditional lethal gene that would be activated by some substance or environmental cue such as high temperature or diapause. One promising type of candidate "cargo" gene is a thermally activated TRPA1 cation channel [65]. Specifically, TRPA1 is an ion channel located on the plasma membrane of many human and animal cells, and is finely tuned to detect specific temperatures ranging from extreme cold to noxious heat [65]. Upon exposure to a critical "threshold" temperature, this cation channel can "open" and modulate Ca2+ and Mg2+ entry into the cell [73]; when TRPA1 is overexpressed in an exogenous tissue (such as the fly brain, for example), this "opening" can lead to total fly paralysis and death. We therefore would like to engineer *D. suzukii* to express a specific TRPA1 channel in the brain, so that exposure of the engineered individuals to a threshold temperature (determined by the specific TRPA1 channel used) would paralyze/kill the flies. We should then be able to spread this temperature-activated "cargo" gene through wild populations by using our *Medea* system during cooler months, and achieve population suppression when the TRPA1 gene is activated in warmer months.

To achieve this, we are working to leverage data from the Montell lab (UCSD), which is developing this technology for mosquito control. The Montell lab is currently testing several TRPA1 channels with different activation temperatures (including rattlesnake TRPA1, python snake TRPA1, boa snake TRPA1 and fruit fly TRPA1) in *D. melanogaster* as a proof of principle, and has preliminary data indicating that at least some of the tested TRPA1 channels, when expressed in the fly brain, work as expected. Once we know which TRPA1 channel appears most promising, we will insert it into our best *Medea* element and begin testing this approach in *D. suzukii*.

Developing a field-ready strain

The above efforts should allow us to engineer both a robust gene drive system capable of spreading linked genes into varying geographic populations, and an effective "cargo" gene that can be activated to bring about population suppression. We will then engineer a strain containing both elements (i.e., a functional TRPA1 element linked to our best *Medea* element) that could be used for wild releases. Laboratory and caged field trials will then be conducted on this strain to determine mating competitiveness, longevity, and fitness compared to wild flies. This data will be used and fed into mathematical models to predict the introduction frequencies we will need to use to achieve suppression. Gene drive experiments will be initiated at various introduction frequencies to characterize the population suppression dynamics. Modeling work will occur in collaboration with Dr. John Marshall, a mathematical biologist with whom we have worked on a number of modeling studies.

Since the ultimate goal here is to develop a product (a genetically modified *D. suzukii*) that can be mass-reared and deployed into the wild to catalytically suppress, and completely eliminate, the wild populations of *D. suzukii*, we will need regulatory bodies to permit such releases. In brief, this involves requesting a permit from USDA-APHIS BRS/PPQ. APHIS is responsible for issuing permits for the import, transit and release of regulated animals, animal products, veterinary biologics, plants, plant products, pests, organisms, soil, and genetically engineered organisms. These permits have been successfully issued for the release of transgenic insects in the USA. For example, in 2009 the USDA approved the integration of genetically engineered pest insects (including pink bollworm moth (*P. gossypiella*), Mediterranean fruit fly (*Ceratitis capitata*), Mexican fruit fly (*Anastrepha ludens*), and oriental fruit fly (*Bactrocera dorsalis*)) into ongoing SIT programs [51]. These insects have been engineered to carry either a heritable marker gene, or a heritable marker gene and a repressible female lethality gene resulting in the production of only males. Transgenic insects have also been developed, and released into the wild, to prevent human disease. For example, a biotech company based in the UK, known as Oxitec, is commercially generating genetically modified mosquitoes and releasing them, in populated cities, in many countries including the Cayman Islands, Malaysia, and Brazil [51.] These GM mosquitoes are likely going to be released in the USA. Therefore, the key point here is that obtaining regulatory approval for releasing transgenic insects in the USA, that are engineered to reduce wild populations and prevent crop damage, has been achieved in the past, and therefore we do not envision it to be a limitation with our approach.

We have been working with Nick Matteis from the CCB and others to begin the process of applying for an APHIS permit. Once a permit is granted, a possible experimental path to utilization would involve mark-release-recapture studies, and collections at different times of year to create a picture of the structure of *D. suzukii* population and the extent of migration. Simulation models parameterized with these data and field cage competition assays would then be used to propose release strategies that could be cost effective and yield population suppression or eradication as quickly as possible in specific high value environments.

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EXECUTIVE SUMMARY

Drosophila suzukii is a major invasive pest of many small fruits, and has caused significant damage in agricultural industries of western North America. Control measures have largely relied on prophylactic application of broad-spectrum insecticides, which is problematic, as repeated use of insecticides is expensive, has had a serious impact on beneficial arthropods, and makes it inevitable that resistance will arise in the foreseeable future. However, there are no effective alternatives to managing *D. suzukii* infestation, and it is likely that this pest will continue to spread.

An alternative, highly promising approach that could complement existing control methods is genetic pest management, which includes strategies such as gene drive. In particular, engineered *D. suzukii* gene drive strains can be utilized to spread desirable genes (e.g., susceptibility to a novel bio-friendly pesticide) throughout, or to entirely suppress/eradicate, wild *D. suzukii* populations. Such an approach is catalytic, with release of only modest numbers of engineered insects required to spread desirable genes or achieve population suppression, and can be cheap, since it relies on only a few releases of transgenic insects. A major appeal of this approach is that it is environmentally friendly and entirely insect-specific, and would have no effect on crops or on beneficial organisms. Our objective over the last year, therefore, was to make progress towards engineering *Medea* and Cas9-mediated gene drive systems in *D. suzukii*.

We had previously developed the first *D. suzukii* functional replacement gene drive system termed *Medea*, had rigorously tested it in laboratory cage populations, and had characterized it in different genetic backgrounds to determine effectiveness and fecundity (our results on this project were published in *PNAS* this year). We found that this first-generation *Medea* system was capable of biasing Mendelian inheritance rates with up to 100% efficiency and could maintain itself at high frequencies in a wild population; however, drive resistance, resulting from naturally occurring genetic variation and associated fitness costs, was present and could hinder the spread of such a drive. Therefore, since mathematical modeling indicated that our *Medea* drive system could spread to fixation if either its fitness costs or toxin resistance were reduced, we have developed a modified version of this same system that should obviate the specific resistance that we observed, and have preliminary evidence to suggest that it does, in fact, function better that the original *Medea* we tested. We have also developed a second-generation *Medea* system in *D. suzukii* that should be more robust in the face of genetic diversity in general and could be used to replace the original *Medea* in case a recall is necessary. Finally, we have identified several promising putative cargo genes that could be spread with the *Medea* gene drive to cause population suppression, and are moving forward with testing them in *D. suzukii*.

We have also made significant progress in developing the tools needed to engineer CRISPR/Cas9 based gene drives (including Y-chromosome drive and Cas9-mediated homing-based drive) in *D. suzukii*. Specifically, we have developed and characterized multiple Cas9 transgenes in *D. suzukii* that are highly functional and enable efficient Cas9-mediated mutagenesis in this pest. We have also developed several ways to efficiently express gRNAs from the *D. suzukii* genome. Together, these tools enable efficient CRISPR/Cas9-based manipulations of the *D. suzukii* genome, and provide the basis for building Cas9-based gene drives. Furthermore, we have developed/optimized several components needed to build Y-gene drive, including identifying *D. suzukii* X and Y chromosome regions, identifying putative X chromosome specific target sites, and efficiently engineering the Y chromosome of flies. Additionally, we have also taken steps towards engineering Cas9-based suppression gene drive, including identifying promising candidate genes to be targeted by this drive, finding *D. suzukii* homologues of and identifying suitable gRNA target sites within these genes, designing gRNA-expressing transgenes to test our ability to target these genes, and building a proof of principle Cas9-based homing system in the white gene to test its ability to self-replicate. We can now begin putting these components together to generate functional suppression gene drives in *D. suzukii*.

2018-2019 FUTURE RESEARCH

At the start of the year, the Research Committee for the California Blueberry Commission discussed current and future research projects. Two projects were approved for the 2018-2019 season.

1. Quality Evaluation of Key Varieties following Sulfur Dioxide Fumigation.
   Principle Researcher: Dr. Spencer S. Walse

2. Engineered Transgenic Drosophila Suzukii for Wild Population Suppression and Eradication.
   Principal Researcher: Dr. Omar S. Akbari

2018/2019	**Amount**
Quality Evaluation of Key Varieties following Sulfur Dioxide Fumigation	$15,000
Engineered Transgenic Drosophila Suzukii for Wild Population Suppression and Eradication	$15,000
FISCAL IMPACT FOR 2018/2019:	**$30,000**

It should be noted that the California Blueberry Commission is partnering with the California Cherry Board to contribute $15,000 to the total budget to the research project Engineered Transgenic Drosophila Suzukii for wild population suppression and eradication. The total project budget equals $80,000.

CALIFORNIA BLUEBERRY

PROJECT PLAN / RESEARCH GRANT PROPOSAL

Work group / Department: USDA-ARS-SJVASC, Crop Protection and Quality Unit

Project Year: 2019 Anticipated Duration of Project: Year 1 of 2

Project Title: Quality evaluation of key varieties following sulfur dioxide fumigation

Principle Investigator: Spencer S. Walse

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Cooperating Investigators:

David Obenland, Chang-lin Xiao, Steve Tebbets, USDA-ARS-SJVASC

Current 2019 Funding Request: $15,000

BACKGROUND/JUSTIFICATION

Sulfur dioxide will soon be available to US growers/packers. The proposed label will allow for the application of up to 10,000 ppmv (1% chamber volume) sulfur dioxide for 30 min. This fumigation scenario is totally consistent with the fumigation of table grapes in California (for SWD and black widow spider control) and is generally consistent with the fumigation of blueberries in Chile. Grape growers/packers in California and blueberry growers/packers in Chile have observed variety-specific responses to such fumigation. We intend to evaluate the effect of the fumigation on the quality of key California blueberry varieties.

Long-term research goal. The overreaching goal of this project is to ensure pest-free blueberries are channeled to markets.

Short-term research goal. Evaluate the quality of blueberries following fumigation with sulfur dioxide.

2019 OBJECTIVES:

This project is planned in phases as indicated below. Each phase will have its own goals and these goals will feed those of the following phase. Year 1 involves the evaluation of three varieties identified/recommended by industry. Year 2 will expand on the research by including more varieties or replicating the Year 1 work.

Year 1 Objectives:

1) Fumigate three varieties with 10,000 ppmv for 30 min at 60F and then evaluate quality per the methods of Obenland over the course of cold-storage. Fumigations will be conducted

in 1 ft^3 chambers.

Timeline: summer 2019.

2) Fumigate three varieties with 5,000 ppmv for 30 min at 60F and then evaluate quality per the methods of Obenland over the course of cold-storage. Fumigations will be conducted in 1 ft^3 chambers.

   Timeline: summer 2019.

3) Fumigate three varieties with 2,500 ppmv for 30 min at 60F and then evaluate quality per the methods of Obenland over the course of cold-storage. Fumigations will be conducted in 1 ft^3 chambers.

   Timeline: summer 2019.
   .

4) Fumigate three varieties with 10,000 ppmv for 20 min at 60F and then evaluate quality per the methods of Obenland over the course of cold-storage. Fumigations will be conducted in 1 ft^3 chambers.

   Timeline: summer 2019.

5) Fumigate three varieties with 10,000 ppmv for 10 min at 60F and then evaluate quality per the methods of Obenland over the course of cold-storage. Fumigations will be conducted in 1 ft^3 chambers.

   Timeline: summer 2019.

2019 BUDGET REQUEST

Supplies and Expenses

Fruit	10,500
GC-glassware	3,000
fumigants	500
travel	1,000
Total:	$15,000

AES/CE MAR 84 Workgroup/Department:

University of California
Division of Agricultural Sciences

PROJECT PLAN/RESEARCH GRANT PROPOSAL

Project Year: 2019 Anticipated Duration of Project: 3 years

Project Leader: Omar S. Akbari, PhD Location: University of California, San Diego, La Jolla, CA

Cooperating Personnel: Anna Buchman, PhD, University of California, San Diego, La Jolla, CA

Project Title: Engineered transgenic *Drosophila suzukii* for wild population suppression and eradication: production, performance assessment, and effective wild releases.

Keywords *Drosophila suzukii*, transgenic, population replacement, eradication, suppression

Commodity Sweet Cherry Relevant AES/CE Project No

BUDGET REQUEST

Funding Source		
Salaries and Benefits		
Postdocs/RA's		$ $17,624
SRA's		$
Lab/Field Assistance		$
Subtotal	Sub 2	$ $17,624
Employee benefits	Sub 6	$ $3,641
	SUBTOTAL	$ $21,265
Supplies and Expenses.	Sub 3	$ 58,135
Equipment	Sub 4	$ 0
Travel Sub 5		$ 600
	TOTAL	$ 80,000

PROBLEM AND ITS SIGNIFICANCE:

Spotted wing Drosophila, *D. suzukii*, is a major worldwide crop pest of various soft-skinned fruits [1]. Unlike other Drosophilids that prefer to oviposit on overripe fruits, *D. suzukii* utilizes its serrated ovipositor to lay eggs inside ripening fruits, causing significant crop losses [1–3]. Found only in Japan prior to the 1930's[4], in the last several decades *D. suzukii* has spread invasively to every continent except Antarctica [1,5]. In the United States, for example, *D. suzukii* was initially discovered in Santa Cruz, California, in 2008, and since then has rapidly invaded many states and is a significant threat to fruit industries across the country [2]. For example, between 2009-2014, *D. suzukii* caused an estimated $39.8 million in revenue losses for the California raspberry industry alone [6], and is responsible for 20%-80% crop losses in other fruit production areas [1,3,4,6], including significant damage in the berry- and cherry-growing industries of western North America [7–10]. Current methods to control *D. suzukii* rely considerably on the use of expensive, broad-spectrum insecticides (e.g., malathion), which have variable efficacy [5], are difficult to use due to timing of fruit infestation [11], and face the risk of *D. suzukii* evolving resistance [12] . (In fact, the first incidence of spinosad resistance in the US has just been reported in California [13].) Additionally, use of broad-spectrum insecticides has led to disruption of integrated pest management systems developed for crops such as cherries and berries, and has had a serious impact on beneficial arthropods, resulting, for example, in an increased use of miticides [9]. However, there are no effective alternatives to managing *D. suzukii* infestation, and it is likely that, unless more effective control measures are developed, this pest will continue to spread [14].

An alternative, highly promising approach that could complement existing control methods is genetic pest management [15], which includes strategies such as gene drive [16,17] and transgenic-based precision-guided Sterile Insect Technique (pgSIT) [18,19]. In particular, engineered *D. suzukii* gene drive strains can be utilized to spread desirable genes (e.g., susceptibility to a novel bio-friendly pesticide) throughout, or to entirely suppress/eradicate, wild *D. suzukii* populations. Such an approach is catalytic, with release of only modest numbers of engineered insects required to spread desirable genes or achieve population suppression. Additionally, since such a system relies on only a few releases of transgenic insects to do the all of the work on an ongoing basis, it is cheap as compared to the use of insecticides, which need to be applied regularly. Finally, such an approach is environmentally friendly and entirely insect-specific, and would have no effect on crops or on beneficial organisms.

Our objective is to therefore engineer *D. suzukii* gene drive strains that could be utilized as part of current integrated pest management programs to control wild *D. suzukii* populations. Specifically, out of the multiple types of gene drive systems that can be utilized in a genetic pest management program [17,20], we aim to develop synthetic *Medea* elements that can be used to suppress wild *D. suzukii* populations. We also aim to develop CRISPR/Cas9 gene drive elements, including Y-chromosome drive and Cas9-mediated homing-based drive, that can be employed as suppression gene drives. Ultimately, our goal is to develop a product (a genetically modified *D. suzukii*) that can be mass-reared and deployed into the wild to catalytically suppress, and completely eliminate, the wild populations of this significant pest.

OBJECTIVES:

I. Objective A - Development of a *D. suzukii Medea*-based gene drive system for population suppression

Out of the multiple types of gene drive systems that can be utilized in a genetic pest management program [17,20], we are interested in developing a synthetic *Medea* gene drive system for population suppression. *Medea* was first discovered in the flour beetle [21], and multiple versions were later reverse engineered from scratch and shown to act as robust gene drives in the laboratory fruit fly, *Drosophila melanogaster* [22,23]. Such engineered *Medea* systems rely on a *Medea* element consisting of a toxin-antidote combination (Figure 1). The toxin consists of a miRNA that is expressed during oogenesis in *Medea*-bearing females, disrupting an embryonic essential gene. A linked antidote is expressed early during embryogenesis and consists of a recoded version of the target gene that is resistant to the miRNA. This combination results in the survival of half of the embryos originating from a *Medea*-bearing heterozygous female, as those that do not inherit the *Medea* element perish. If a heterozygous *Medea* female has mated with a heterozygous

Medea male, the antidote from the male will also take effect in the embryo, resulting in 3/4 of the embryos surviving (Figure 1). Therefore, *Medea* will rapidly spread through a population, carrying any linked genes with it.

In the case of *D. suzukii*, since elimination of the pest population is ultimately the goal, an engineered *Medea* system could spread a gene proffering susceptibility to a particular pesticide, or a conditional lethal gene that would be activated by some substance or environmental cue such as high temperature or diapause - a state that allows insects survive periods of adverse conditions such as cold [24].

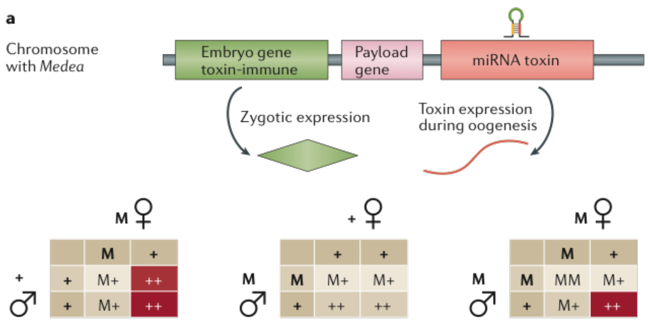

Figure 1

For example, a *Medea* element can be used to spread a gene conferring sensitivity to a particular chemical that is normally innocuous, rendering such a chemical capable of being used as an environmentally-friendly, species-specific pesticide. Trigger-inducible transcription control elements – ones that turn on expression in the presence of a chemical such as tetracycline or vanillic acid [25,26] – can be engineered to drive expression of an insect-specific toxin (e.g., [27]). A *Medea* element can also be used to spread a gene under the control of a diapause-induced promoter that will splice to produce a toxin in females only, so that, upon the onset of the diapause-inducing environmental cue, all of the females will perish, causing a population crash [22]. Furthermore, a *Medea* element can be utilized to spread a thermally activated TRPA1 cation channel [28] that, upon exposure to a specific threshold temperature, renders flies paralyzed or dead.

We have already engineered a first-generation *Medea* system in *D. suzukii* [29], which is the first functional gene drive developed in this pest. We had rigorously tested it in laboratory cage populations, and had characterized it in different genetic backgrounds to determine effectiveness and fecundity (our results on this project were published in *PNAS* this year [29]). We found that this first-generation *Medea* system was capable of biasing Mendelian inheritance rates with up to 100% efficiency and could maintain itself at high frequencies in a wild population; however, drive resistance, resulting from naturally occurring genetic variation and associated fitness costs, was present and could hinder the spread of such a drive. Therefore, since mathematical modeling indicates that our *Medea* drive system could spread to fixation if resistance was reduced [29], we need to engineer a second-generation *Medea* system that should obviate the specific resistance that we observed.

To safeguard, reduce risk, and mitigate the spread of the *D. suzukii Medea* system into wild populations, we also aim to develop a reversal *Medea* (RM) system that can be used to replace the original *Medea* in case a recall is necessary. Reversing the drive of a *Medea* system has been theorized; however, it has never been experimentally demonstrated.

Finally, in order to use *Medea* to bring about population suppression, we need to link it to a cargo gene capable of killing *D. suzukii* under specific conditions to bring about a population crash. We have already identified several promising putative cargo genes and are testing them in *D. melanogaster*, a closely related species to *D. suzukii* that is easier to work with and provides a useful testing platform for transgenes. However, we will still need to build and test them in *D. suzukii*.

Successful completion of the above objectives would lead to the development of a genetically modified *D. suzukii* strain (carrying a synthetic *Medea* element) that can be mass-reared and deployed into the wild to catalytically suppress, and completely eliminate, wild populations of *D. suzukii*.

II. <u>Objective B - Development of CRISPR/Cas9-based drive systems in *D. suzukii*</u>

The arrival of CRISPR technologies heralded a new era for traditional genome manipulation and site-specific transgenesis [30,31], and for advanced engineering of target genomes including the construction of gene drives [20,32]. Out of all the types of gene drives that have been proposed, drives based on the CRISPR/Cas9 gene-editing system may be the simplest to build (especially given CRISPR's functionality in many insects [33–41]) and the most effective [17]. Most CRISPR technologies used in insects utilize a simplified two-component system consisting of a *S. pyogenes* Cas9 endonuclease (SpCas9) and a single chimeric guide RNA (gRNA) [42] that can generate DNA double-strand breaks (DSB) in a location of one's choosing. These breaks can them be repaired either randomly (via non-homologous end-joining, NHEJ) or based off a template (via homology-directed repair, HDR) [42,43]. The functionalities of CRISPR/Cas9 systems can be exploited to bring about gene drive-based population suppression.

For example, distortion of the sex ratio in favor of males can lead to a gradual population reduction and eventual elimination of a target population [44–47], and natural so-called meiotic driving Y-chromosomes have been described [48–50]. A system for sex-ratio distortion can also be engineered by designing CRISPR-based transgenes that target the X-chromosome during spermatogenesis [51,52](Figure 2). This Y-gene drive approach would depend on the destruction of X-bearing sperm to produce males that only give rise to male progeny [20,53], and would require the ability to meiotically express an X-chromosome targeting element from the Y-chromosome [51,54]. Importantly, CRISPR/Cas9 technology could straightforwardly be utilized to engineer Y-gene drive elements by designing gRNAs that target only the X chromosome [51,52]. Such a system has already been developed in one species of mosquito [51,55,56], and should be portable to *D. suzukii*.

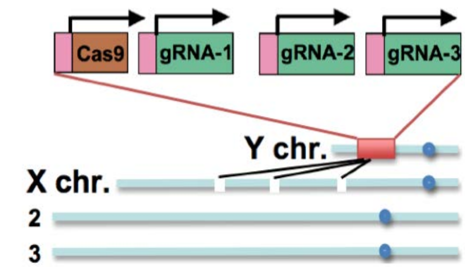

Figure 2

Another way CRISPR/Cas9 can be utilized to bring about population suppression is via Cas9-mediated homing-based gene drive [20]. This concept is based on the idea of using homing endonuclease genes (HEGs) to manipulate populations [57]. These genes are extraordinarily selfish, and this property can be exploited for both population suppression and replacement. HEGs have the ability "cheat" during meiosis by converting their corresponding allele on the opposite chromosome into an exact copy of themselves, by encoding a sequence-specific endonuclease that severs and disrupts their competing chromosomal allele, which can force the call to use the HEG as a template for homology-directed repair (HDR), resulting in the HEG copying itself (i.e., homing) into its competing allele. If the latter repair option occurs in the germline, or early embryo, then the proportion of offspring that receive the HEG will be above that expected with normal Mendelian transmission (i.e., 50%), allowing for rapid invasion of the HEG into a target population [58]. A HEG can be used to spread a payload gene (replacement drive) or for population suppression and possibly eradication by homing into a target gene, the disruption of which leads to recessive lethality or sterility (Figure 3). In such a suppression approach, homing must be confined to the germline during gamete formation, leading to sterility/non-viability only in homozygotes that receive the HEG allele from both parents. Consequently the HEG can rapidly spread, and once a large fraction of the population is heterozygous, it can cause a population crash as heterozygote pairings will produce sterile/non-viable offspring. Although several proof-of-principle studies have shown the utility of HEGs as gene drives prior to the advent of CRISPR/Cas9 (e.g., [59]), this powerful system is enabling the efficient design of homing-based drive systems in many contexts [32]. Several replacement Cas9-mediated homing-based gene drives have been developed [33,60,61]; additionally, several Cas9-based suppression drive systems have recently been engineered in fruit flies [62,63] and one species of mosquito [35,64], and should also be possible to transfer to *D. suzukii*. However, neither this approach nor Y-gene drive have been developed in this pest species.

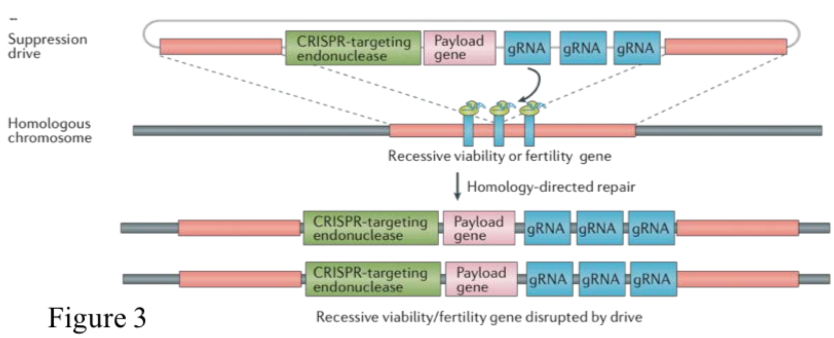

Figure 3

PLANS AND PROCEDURES:

Objective A - Development of a *D. suzukii Medea*-based gene drive system for population suppression

Preliminary Results and Future Directions

Generation and characterization of a first-generation synthetic *Medea* element

Previously, we described the creation of a synthetic *Medea* gene drive in *D. suzukii* (Figure 4). Specifically, we engineered a *piggyBac* vector comprising a miRNA toxin coupled with a toxin-resistant antidote, inspired by the architectures used to generate previous *Medea* systems in *D. melanogaster* [23,65]. We designed synthetic miRNAs to target *D. suzukii* myd88, a highly conserved gene shown to be maternally deposited and required for dorsal-ventral patterning in the early embryo in *D. melanogaster* [66] (Figure 4A). We used the predicted *D. suzukii* female germline-specific bicoid (BicC) promoter to drive expression of a “toxin” consisting of a polycistronic array of four synthetic microRNAs (miRNAs) each designed to target the 5’ untranslated region (UTR) of *D. suzukii* myd88. This *Medea* drive also contained an “antidote” consisting of the *D. suzukii* myd88 coding region, insensitive to the miRNAs as it did not contain the miRNA-targeted 5’UTR, driven by the predicted *D. suzukii* early embryo-specific bottleneck (bnk) promoter, and two separate transformation markers – eGFP driven by the eye-specific 3xP3 promoter [67], and dsRed driven by the ubiquitous hr5-IE1 promoter [68] (Figure 4F).

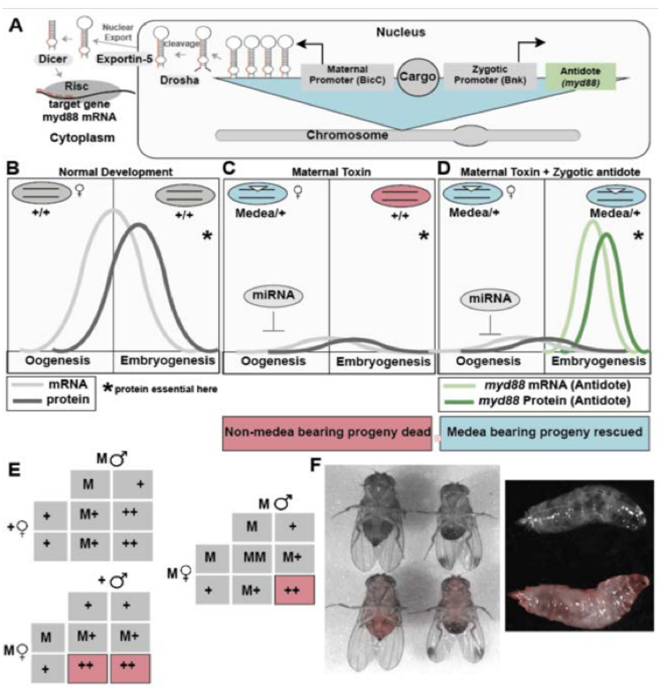

Figure 4

Following microinjection of the *Medea* transgene into *D. suzukii* embryos, a single G_1 transformant male was recovered, as identified by ubiquitous hr5-IE1 driven expression of dsRed (Figure 4F), and weak eye-specific 3xP3-driven eGFP. When outcrossed to several wildtype (non-*Medea* bearing; +/+) females, this male produced roughly ~50% *Medea*-bearing and ~50% wildtype offspring, as would be expected from standard Mendelian segregation without biased inheritance. Resulting heterozygous G_2 *Medea*-bearing progeny were individually outcrossed to wildtype individuals of the opposite sex to determine inheritance patterns, and these individual outcrosses were continued for six generations. Remarkably, until the G_5 generation, all heterozygous *Medea*/+ mothers (n = 91) produced 100% *Medea*-bearing progeny (n = 1028), while heterozygous *Medea*/+ fathers (n = 16) produced ~50% *Medea*-bearing progeny (n = 268). While the majority of heterozygous *Medea*/+ G_5 (23/31) and G_6 (16/25) generation females also produced 100% *Medea*-bearing progeny, some heterozygous G_5 (8/31), and G_6 (9/25) females unexpectedly produced a small yet notable number (52/1219) of wildtype offspring. Although the exact reason for the difference is unclear, later analysis suggested that resistance to the miRNA toxin might explain this unexpected observation. Notwithstanding, individually these G_5 and G_6 heterozygous *Medea*/+ females displayed significantly biased biased inheritance rates ranging from 76%-96%, with an average rate of 86.4%. Overall, in six generations of individual female outcrosses, the percentage of *Medea*-bearing progeny borne by single heterozygous *Medea*/+ mothers (n = 147) was 97.7% (2195/2247) as opposed to the 50% that would be expected with standard Mendelian segregation, indicating that the *Medea* drive is extremely functional at biasing inheritance.

To understand whether resistance of the target mRNA to the toxin played a role in observed *Medea* inheritance rates of <100%, we performed genomic DNA sequencing of the myd88 5’UTR miRNA target region from *Medea*/+ and +/+ progeny from the crosses described above. Genomic sequence analysis revealed that, out of 4 miRNA target sites, one to two sites were perfectly conserved in *Medea*/+ individuals (site #4 or sites #1 and #4, depending on the individual), while only one (site #4) was perfectly conserved in +/+ individuals; additionally, for sites that were not perfectly conserved (i.e., had mutations; #1-3), some of the mutations were the same for *Medea*/+ and +/+ flies (for sites #2 and #3), while others were only found in one type of fly or the other (for site #1). To further this analysis, we also sequenced +/+ individuals from all of the geographically distinct populations tested above, and discovered a similar trend - i.e., that only one of the four miRNA target sites was perfectly conserved (#4), two others (#2 and #3) had the same mutations in all strains (including the *Medea*/+ and +/+ individuals above), and a third site (#1) had variable mutations that appeared to correlate with *Medea* efficiency. Together, these observations indicate that the nature of mutations differed between backgrounds correlating with observed *Medea* inheritance rates, suggesting that the efficiency of the miRNA "toxin" is likely influenced by resistance alleles, which influence *Medea* transmission.

To assess whether the *D. suzukii Medea* could function in geographically distinct populations that possibly harbor genetic variability in regions that canonically have less conservation such as the 5'UTR, heterozygous *Medea*/+ flies were tested in eight additional *D. suzukii* strain backgrounds. These strains were collected from various locations around the world, including: Mt. Hood, OR; Clayton, WA; Brentwood, CA; Tracy, CA; Watsonville, CA; Oahu, HI; Beltsville, MD; and Ehime, Japan. Interestingly, for 3/8 strains, the *Medea* inheritance rate from heterozygous *Medea*/+ mothers was 100%, while from 5/9 strains the inheritance rate ranged from 87.6% to 99.4%, with an overall transmission rate of 94.2%. These results strongly demonstrate that the *Medea* drive described here can dominantly bias transmission in diverse *D. suzukii* populations.

The above observations suggested that *D. suzukii Medea* should be able to drive robust population replacement. To test this prediction, we performed several long term multi-generational population cage experiments specifically challenging the *Medea* drive with a wildtype strain that harbored pre-existing resistance (Corvallis, OR). We set up these population cage studies after maintaining this population for approximately ten generations, we mated *Medea*-bearing fathers to wildtype Corvallis, OR, strain mothers at three distinct introduction (G_0) frequencies: low frequency (25 heterozygous *Medea*/+ and 25 wildtype +/+ males mated to 50 wildtype +/+ virgins, *Medea* allele frequency of ~12.5% and genotype frequency of ~25%); medium frequency (50 heterozygous *Medea*/+ males mated to 50 wildtype +/+ virgins, *Medea* allele frequency of ~25% and genotype frequency of ~50%); and high frequency (50 homozygous *Medea*/*Medea* males mated to 50 wildtype +/+ virgins, *Medea* allele frequency of ~50% and genotype frequency of ~50%). These experiments were conducted in separate bottles in biological triplicate for the low and medium threshold and quadruplicate for the high threshold drives, producing ten distinct populations with G_1 *Medea* allele frequencies ranging from ~12.5-50% and genotype frequencies ranging from ~25-100%. Altogether, these population cage experiments were followed for 9 generations (for lower allele frequency populations, as the *Medea* allele disappeared from the population by that time) or 19 generations (for higher allele frequency populations), counting the number of *Medea*-bearing adults each generation to determine the genotype frequency, as described previously [23,65]. Interestingly, the observed changes in *Medea* frequency over time indicated that, for release proportions (defined as the genotype frequency in the G_1 population) of 50% or smaller, the *D. suzukii Medea* drive was unable to drive into the wildtype population, likely because of selected drive resistance combined with high fitness costs outweighing the effect of drive. However, at higher release proportions of >90%, similar to classical chromosomal rearrangement thresholds [69], the drive largely compensated for the fitness cost, allowing the gene drive to remain in the population at high frequencies for the duration of the experiment (19 generations). Although unintended, the self-limiting dynamics of the generated *Medea* system may be useful in achieving a transient population transformation of the type associated with other proposed gene drives (e.g.,[70]).

To characterize the population dynamics observed in the above cage experiments, we fitted a mathematical model to the observed data in which the *Medea* drive had an associated fitness cost in heterozygotes and homozygotes and there was a *Medea*-resistant allele present in the population that reduced toxin efficiency. For the fitted model, the *Medea* drive was estimated to have a toxin efficiency of 93% in individuals homozygous for the resistant allele (95% credible interval (CrI): 90-95%) and was assumed to have a toxin efficiency of 100% in individuals lacking the resistant allele. The *Medea* drive was estimated to confer a large fitness cost on its host - 28% in heterozygotes (95% CrI: 27-30%) and 65% in homozygotes (95% CrI: 62-67%) - and the resistant allele was estimated to have an initial allele frequency of 78% in the population (95% CrI: 57-97%).

Predictive mathematical modeling based on these parameter estimates suggests that the *Medea* drive would spread to fixation in the absence of toxin resistance if released above a threshold frequency of 79%. Spread to fixation would also be expected if the fitness costs of the generated *Medea* drive were halved, even if all individuals in the population were homozygous for the *Medea*-resistant allele, provided the drive was released above a threshold frequency of ~25-27%. Consistent with the experimental results, a *Medea* drive with a large fitness cost in a *Medea*-resistant population is expected to be maintained at high frequencies through its drive; however, its eventual elimination is inevitable unless supplemental releases are carried out. However, for high release frequencies (90-95%), the drive may be maintained at high frequencies (>75%) for ~20 generations, which likely exceeds the duration required for agricultural impact.

Improved *Medea* Construct and Reversal *Medea*

Given our observations regarding resistance and its effect on *Medea* function, we now need to engineer improved *Medea* systems that could reduce the chances of resistance acting as an impediment to spread. So far, we have performed some sequencing-based characterization of naturally occurring genetic variation in various geographically distinct target populations to help guide selection of target sites that are well conserved across all populations in which the drive is intended to function. We then designed a modified version of the original *Medea* system that targeted different, conserved sequences (still in the 5'UTR of the *myd88* target gene), reasoning that such a *Medea* element should function very similarly to the original element but not be impeded by the resistance we previously observed. We are now obtaining transgenic lines for this improved *Medea* element, and preliminary data indicates that it works better than the original *Medea*, producing 100% inheritance bias. In the coming year, we need to rigorously test this second-generation *Medea* element to characterize its function and ability to bias inheritance 100% in geographically distinct populations. We also will need to perform multiple long term multi-generational population cage experiments to determine whether this *Medea* can drive robust population replacement.

Additionally, we hypothesized that to reduce resistance, miRNA target site selection could be limited to the coding DNA sequence regions of a genome, which tend to be strongly conserved, as opposed to regions such as the 5'UTR, which canonically have higher tolerance for sequence variation. We have therefore also developed a second-generation "reversal" *Medea* system in *D. suzukii* that should be more robust in the face of genetic diversity in general (because it targets coding DNA regions as opposed to the 5'UTR) and could be used to replace the original *Medea* in case a recall is necessary (Figure 5). Specifically, to reduce risk and mitigate the spread of the *D. suzukii Medea* system into wild populations, it is important to develop a reversal Medea (RM) system and demonstrate that it can function as predicted. Reversing the drive of a *Medea* system has been theorized; however, it has never been experimentally demonstrated. Therefore, this should be of high impact and relevance when it comes to regulators assessing the risk associated with gene drives. We have finished designing and building a reversal *Medea* system capable of spreading on its own and of replacing the first *Medea* described above, and are in the process of obtaining transgenic *D. suzukii* individuals containing this *Medea*. Once we have transgenic lines for this construct, we need to rigorously test them for their ability to bias inheritance in both wild type and original *Medea* backgrounds. We will then need to perform multiple long term multi-generational population cage

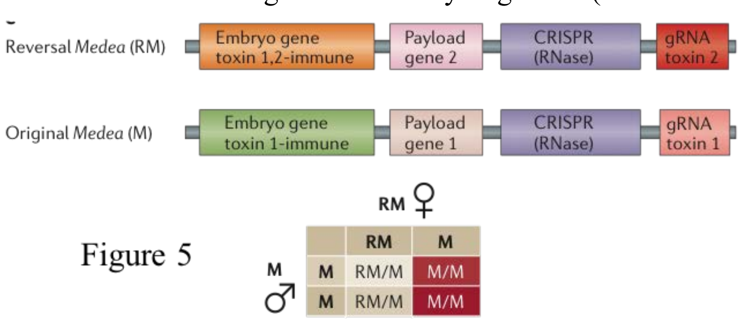

Figure 5

experiments to determine whether this *Medea* can actually spread on its own (in a wild type population) and replace the original *Medea*.

<u>Identification of Putative "Cargo" Genes</u>

For *D. suzukii*, elimination of the pest populations is ultimately the goal. An engineered *Medea* system could achieve this by spreading a "cargo" gene proffering susceptibility to a particular pesticide, or a conditional lethal gene that would be activated by some substance or environmental cue such as high temperature or diapause. One promising type of candidate "cargo" gene is a thermally activated TRPA1 cation channel [28]. Specifically, TRPA1 is an ion channel located on the plasma membrane of many human and animal cells, and is finely tuned to detect specific temperatures ranging from extreme cold to noxious heat [28]. Upon exposure to a critical "threshold" temperature, this cation channel can "open" and modulate Ca2+ and Mg2+ entry into the cell [71]; when TRPA1 is overexpressed in an exogenous tissue (such as the fly brain, for example), this "opening" can lead to total fly paralysis and death. We therefore would like to engineer *D. suzukii* to express a specific TRPA1 channel in the brain, so that exposure of the engineered individuals to a threshold temperature (determined by the specific TRPA1 channel used) would paralyze/kill the flies. We should then be able to spread this temperature-activated "cargo" gene through wild populations by using our *Medea* system during cooler months, and achieve population suppression when the TRPA1 gene is activated in warmer months.

To achieve this, we are working to leverage data from the Montell lab (UCSD), which is developing this technology for mosquito control. The Montell lab is currently testing several TRPA1 channels with different activation temperatures (including rattlesnake TRPA1, python snake TRPA1, boa snake TRPA1 and fruit fly TRPA1) in *D. melanogaster* as a proof of principle, and has preliminary data indicating that at least some of the tested TRPA1 channels, when expressed in the fly brain, work as expected. In the coming year, once we know which TRPA1 channel appears most promising, we will design and engineer TRPA1 elements for *D. suzukii* and begin testing this approach. This will allow us to identify the best TRPA1 element to insert into our *Medea* systems.

<u>Developing a field-ready strain</u>

The above efforts should allow us to engineer both a robust gene drive system capable of spreading linked genes into varying geographic populations, and an effective "cargo" gene that can be activated to bring about population suppression. We will then engineer a strain containing both elements (i.e., a functional TRPA1 element linked to our best *Medea* element) that could be used for wild releases. Laboratory and caged field trials will then be conducted on this strain to determine mating competitiveness, longevity, and fitness compared to wild flies. This data will be used and fed into mathematical models to predict the introduction frequencies we will need to use to achieve suppression. Gene drive experiments will be initiated at various introduction frequencies to characterize the population suppression dynamics. Modeling work will occur in collaboration with Dr. John Marshall, a mathematical biologist with whom we have worked on a number of modeling studies.

Since the ultimate goal here is to develop a product (a genetically modified *D. suzukii*) that can be mass-reared and deployed into the wild to catalytically suppress, and completely eliminate, the wild populations of *D. suzukii*, we will need regulatory bodies to permit such releases. In brief, this involves requesting a permit from USDA-APHIS BRS/PPQ. APHIS is responsible for issuing permits for the import, transit and release of regulated animals, animal products, veterinary biologics, plants, plant products, pests, organisms, soil, and genetically engineered organisms. The specific permit we will apply for is BRS 2000 (Application for Permit or Courtesy Permit for Movement or Release of Genetically Engineered Organisms). These permits have been successfully issued for the release of transgenic insects in the USA. For example, in 2009 the USDA approved the integration of genetically engineered pest insects (including pink bollworm moth (*P. gossypiella*), Mediterranean fruit fly (*Ceratitis capitata*), Mexican fruit fly (*Anastrepha ludens*), and oriental fruit fly (*Bactrocera dorsalis*)) into ongoing SIT programs [72]. These insects have been engineered to carry either a heritable marker gene, or a heritable marker gene and a repressible female lethality gene resulting in the production of only males. Transgenic insects have also been developed, and released into the wild, to prevent human disease. For example, a biotech company based in the UK, known as Oxitec, is commercially generating genetically modified mosquitoes and releasing them, in populated cities, in many countries including the Cayman Islands, Malaysia, and Brazil [72]. These GM mosquitoes are likely going to be released in the USA. Therefore, the key point here is that obtaining regulatory approval for releasing transgenic insects in the USA, that are engineered to reduce wild populations and prevent crop damage, has been achieved in the past, and therefore we do not envision it to be a limitation with our approach.

Once a permit is granted, a possible experimental path to utilization would involve mark-release-recapture studies, and collections at different times of year to create a picture of the structure of *D. suzukii* population and the extent of migration. Simulation models parameterized with these data and field cage competition assays would then be used to propose release strategies that could be cost effective and yield population suppression or eradication as quickly as possible in specific high value environments.

Objective B - Development of CRISPR/Cas9-based drive systems in *D. suzukii*

Preliminary Results and Future Directions

Efficient Transgenesis in *D. suzukii*

In order to engineer any type of gene drive system in *D. suzukii*, we first have to be able to efficiently generate transgenic flies. Although transgenesis in *D. suzukii* has been previously established [73], it is not very efficient [74], and we had previously struggled with obtaining *D. suzukii* transgenic fly lines. However, a recent work [75] described the generation of a "jumpstarter" *D. suzukii* strain that carries the *transposase* gene necessary for *piggyBac* transposition, and reported that performing germline transformation in this strain dramatically increased transgenesis rates (in some cases 40- to nearly 60-fold [75]). Since increased rates of transgenesis would help us accelerate our gene drive development efforts, this past year we obtained the USDA/APHIS permits necessary to acquire this transgenic strain from the researchers that developed it, have expanded the obtained stocks into a large colony, and are carrying out all microinjections for transgenesis into this strain. This has been greatly helpful, as we are now able to obtain transgenic lines with much greater efficiency.

Development of Cas9 Tools in *D. suzukii*

The development of both Y-gene drive and Cas9-mediated suppression drive in *D. suzukii* requires functional CRISPR/Cas9 tools in this fly. Although Cas9-mediated genome editing had been previously demonstrated in *D. suzukii* [76], it was carried out by microinjection of gRNAs and Cas9 protein into embryos. Conversely, the building of a gene drive requires a germline source of Cas9 and gRNAs driven by an effective promoter, typically a PolIII promoter such as U6.

Leveraging our experience in designing and optimizing CRISPR/Cas9 tools in *D. melanogaster*, we have generated both of these components. Specifically, we have generated four distinct functional transgenic Cas9 lines, where expression of Cas9 is driven by either strong female germline specific promoters (*BicC* and *Dhd*) or by male and female germline specific promoters (*vasa* and *nanos*) that have been previously validated in *D. melanogaster* [18,61]. We have tested these Cas9 lines, and have shown that all four work, with up to 100% mutagenesis efficiency (for *vasa*-Cas9). We have also generated several functional gRNA-expressing transgenes by targeting the *white* gene, which gives flies a red eye color, as a proof of principle. Specifically, after several failed attempts, we have demonstrated that a genomically encoded, PolIII U6:3 promoter-driven gRNA targeting *white* produces up to 100% mutated (white and mosaic-eyed) progeny when crossed to a Cas9 expressing line (Figure 6). We have also

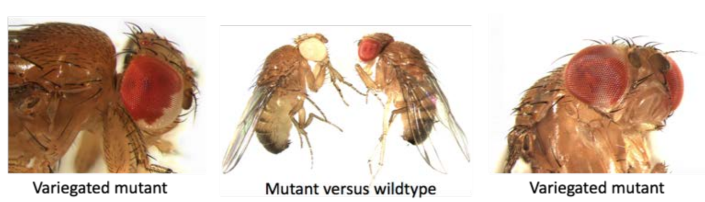

Figure 6

shown that a genomically encoded tRNA-gRNA expression cassette [77], driven by a PolII germline specific promoter, also functions to produce mutated progeny (albeit at a more modest frequency of ~15-30%).

The development of these tools lays the foundation for the ability to engineer Cas9-based gene drives in *D. suzukii*, and we are now using these tools to build Y-gene drive and Cas9-mediated suppression drive.

Engineering a Y-gene Drive System

Assuming that efficient CRISPR/Cas9 tools are available, the ability to build a Y-gene drive requires three further components: the ability to identify X and Y chromosomes in *D. suzukii*; the ability to insert large transgenes on the Y-chromosome; and the ability to target and cut sequences only present on the X-chromosome.

Identifying, and inserting genes on, the Y chromosome in D. suzukii

The current genome annotation of *D. suzukii* (http://spottedwingflybase.org) is divided into over 29, 000 contigs (independent fragments that have not been brought together to make a clear linear sequence map of each chromosome), and it is not entirely clear which of these contigs comes from the *D. suzukii* Y and X chromosomes. Therefore, we have used a bioinformatic approach to try to identify fragments of these chromosomes. To do this, we took the entire *D. melanogaster* Y chromosome sequence and carried out a search for related sequences (a BLAST homology search) among the *D. suzukii* contigs; essentially, we looked for regions of *D. suzukii* that were nearly identical to those from the melanogaster Y chromosome, as these are likely to represent *D. suzukii* Y chromosome sequence. We identified a total of 134 contigs that had extremely high homology (E-value = 0) to the *D. melanogaster* Y chromosome. Given this high homology, we are confident that these contigs are pieces of the *D. suzukii* Y chromosome. From this data we have identified several regions of the putative *D. suzukii* Y chromosome that should be ideal locations for integrating an X chromosome targeting Cas9/gRNA cassette (outside of any known transcribed regions, in unique, non-repetitive DNA).

In order to assay whether we could use CRISPR/Cas9 to dock transgenes on the Y chromosome, we first set out to develop a CRISPR/Cas9-based technique for site-specific engineering of the *D. melanogaster* Y chromosome as a proof of principle [78], as it is much easier and faster to test and troubleshoot components in this species before porting them to *D. suzukii*. To do this, we engineered a vector comprising a fluorescent marker (tdTomato) driven by the eye-specific 3xP3 promoter and flanked by the gypsy and CTCF insulators, with unique restriction sites upstream and downstream for cloning specific homology arms (Figure 7). We then selected ten distinct intergenic regions spanning the Y chromosome for targeting, identified a suitable sgRNA target site in each region, and cloned in homology arms, corresponding to ~800-1,000 base pairs of sequence 5' and 3' of each selected target site, upstream and downstream of the insulator-flanked 3xP3-tdTomato element to generate ten unique Y chromosome targeting transgenes. Each transgene was then injected, along with the appropriate in vitro transcribed sgRNA and Cas9 protein, into a transgenic line expressing a germline source of Cas9 using standard procedures, and G1 progeny were screened for presence of the transgene marker. Two of the injected transgenes inserted in the correct positions on the Y chromosome, demonstrating that we can use the above approach to insert, and detect expression from, a fluorescently marked transgenic cassette at specific locations on the Y-chromosome in *D. melanogaster* using CRISPR/Cas9-mediated HDR.

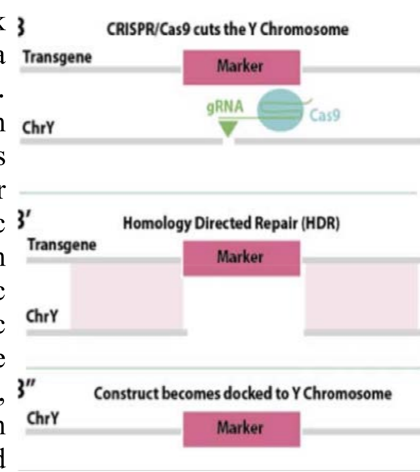

Figure 7

We are now testing whether we can insert, and detect expression from, Cas9-containing transgenes at these same Y chromosome locations, as we will need to be able to express Cas9 cassettes from the Y in order for the Y gene drive approach to work. Specifically, we have designed transgenes that can dock at the previously validated *D. melanogaster* Y chromosome sites that contain Cas9 driven by different promoters, including *ubiquitin* (which expresses everywhere) and *nanos* (which expresses in the male and female germlines), and are currently trying to obtain transgenic flies containing these transgenes so that we can confirm Cas9 expression from the Y chromosome. Once these experiments are complete, we plan to port this approach to *D. suzukii*.

Identifying and cutting the X chromosome in D. suzukii

We performed a similar bioinformatic analysis to the one described above identify the X chromosome of *D. suzukii*, and identified 388 contigs from *D. suzukii* as being X-linked. Then, to identify potential gRNA sequences specific to the *D. suzukii* X chromosome, and present in multiple copies, we first developed a program to predict all possible Cas9 cleavage sites on the X-chromosome by searching for the PAM motif (XGG in the target sequence N(21)XGG). Once potential X-chromosome cleavage sites were identified, they were aligned to the rest of the genome (all the other non-X contigs) and those that showed a sequence match to these contigs were eliminated. The final output of this program was a conservative list of X-chromosome specific Cas9 cleavage sites.

From all of this, we conservatively predicted several potential target sequences repeated exclusively on the X chromosome in up to ten locations, making them ideal for the development of guide RNAs to cleave the *D. suzukii* X chromosome. However, our initial attempts at testing these gRNAs for their ability to cut the X did not succeed because, as discussed above, our initial gRNA-expression configuration were not functional. However, now that we have a highly functional gRNA expression configuration, we are proceeding to clone X chromosome-targeting gRNAs into our gRNA expression cassettes and test them. Once we obtain a gRNA that can effectively cut the X chromosome, we can combine it with one of our previously validated Cas9 designs and attempt to express this cassette from the Y chromosome of *D. suzukii*.

Engineering a Cas9-mediated Suppression Drive System

To engineer a Cas9-mediated suppression homing drive, we need to introduce the coding sequence for Cas9 and gRNA into the genomic site targeted by the Cas9/gRNAs [17] to generate a self-replicating transgene that could continuously mutate a target gene every generation and/or carry a transgene into the population. This self-replicating (i.e., homing) Cas9-based transgene would need to be placed within a gene necessary for female fertility, so that eventually all of the females in a target population would become sterile and the population would collapse [64].

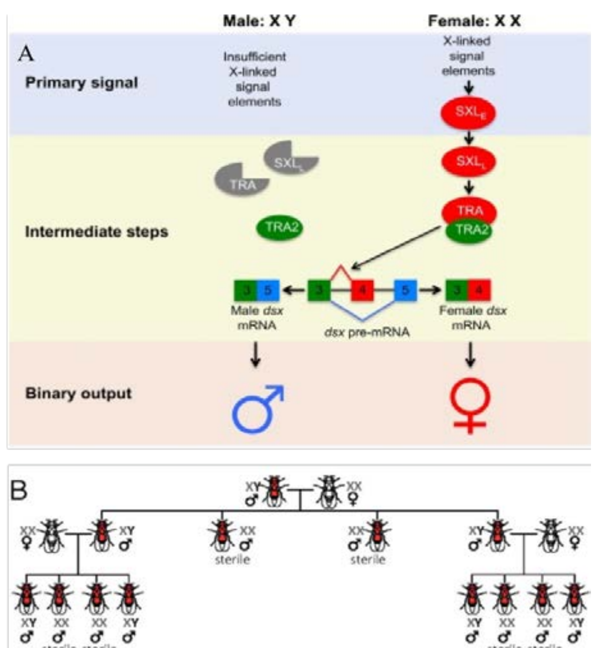

Figure 8

As described above, we now have working Cas9 and gRNA transgenes that we can utilize as the basis for such a gene drive. After analyzing recent efforts to develop such suppression drive systems in fruit flies [62,63] and mosquitoes [64], we have identified several promising candidate target genes, including *dsx*, *tra*, and *sxl*. Specifically, *dsx*, *tra*, and *sxl* are all sex-specifically alternatively spliced sex-determination genes that are essential for female development in fruit flies (Figure 8A). Recent work in *D. melanogaster* has shown that targeting these genes with CRISPR/Cas9 works effectively to either kill females or convert them into sterile pseudomales [18,62], which could function as a basis to bring about population collapse (Figure 8B). Additionally, a recent report has demonstrated that targeting *dsx* with a

Cas9-mediated suppression drive in one species of mosquito can cause complete population collapse [64]. Importantly, all of these genes are conserved in *D. suzukii*, and their disruption should cause the same phenotypes as observed in other insects.

In order to test the suitability *dsx*, *tra*, and *sxl* as target genes for a Cas-mediated suppression drive system, we analyzed the sequences of the *D. suzukii* homologues of these genes to identify regions that are highly conserved and thus unlikely to contain sequence variation. We then selected two optimal gRNA target sites within conserved regions in each gene, and have engineered separate U6-driven gRNA transgenes targeting each gene to test whether the selected gRNA sequences will work to efficiently cut the selected targets. We are currently working on obtaining transgenic lines for these transgenes, which we can then cross to our Cas9 lines to determine whether the selected gRNAs efficiently cut the target sequences. After we verify that the gRNAs work, we will proceed to construct full Cas9-based suppression drive cassettes targeting the most promising candidates (based on gRNA function), and characterizing them for their ability to kill/sterilize/masculinize all females. In parallel, we are also testing a split Cas9-based gene drive cassette [79] targeting the *white* eye color gene as a proof of principle, to determine whether we can: a). dock transgenes in a site-specific location using CRISPR/Cas9 in *D. suzukii*; and b). observe the efficiency of self-replication/homing of this Cas9-based transgene in *D. suzukii*. These efforts should, within the course of a year, allow us to assess the viability of engineering this type of drive system for population suppression of *D. suzukii*.

Developing a field-ready strain

The ultimate goal here is to engineer a Y-gene drive strain and/or a Cas9-mediated suppression drive strain that can be used in the field for *D. suzukii* biocontrol. Once these strains are engineered, as with the *Medea* strains, we will need to conduct laboratory and caged field trials to determine mating competitiveness, longevity, and fitness of these strains as compared to wild flies. This data will be used and fed into mathematical models to predict the numbers of flies we will need to release to achieve suppression. Some key advantages of both of these approaches will be that only males can be released (so crops will not be damaged); that it is very species-specific, with no effect on beneficial organisms; and that the approach is catalytic, with releases of modest numbers of engineered insects leading to the elimination of females and overall population suppression as the relevant transgenes spread into the population.

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Engineered transgenic *Drosophila suzukii* for wild population suppression and eradication.

Proposed Duration: 3 years.
Principal Investigator: Omar S. Akbari, University of California, San Diego; oakbari@ucsd.edu, (858) 246-0640

Problem and Significance/Justification

Drosophila suzukii is a major invasive pest of ripening small fruit including raspberries, blueberries, strawberries, and cherries [1,2]. It has caused significant worldwide economic losses including significant damage in the berry- and cherry-growing industries of western North America [2–5]. Achieving effective control of *D. suzukii* has been difficult in a number of crop systems including cherries [6,7], and control measures have largely relied on prophylactic application of expensive broad spectrum insecticides [6–8]. This is problematic, as the repeated use of broad-spectrum insecticides has led to disruption of integrated pest management systems developed for crops such as cherries and berries, and has had a serious impact on beneficial arthropods, resulting, for example, in an increased use of miticides [4]. Additionally, broad use of insecticides makes it inevitable that resistance will become a major problem in the foreseeable future [8], increases the risk of residues on fruits [8], and arouses public concern [6]. However, there are no effective alternatives to managing *D. suzukii* infestation, and it is likely that, unless more effective control measures are developed, this pest will continue to spread [8].

Our Solution

An alternative, highly promising approach that could complement existing control methods is genetic pest management [9], which includes strategies such as gene drive [10,11] and transgenic-based sterile insect technique (SIT) [12,13]. Our goal, therefore, is to engineer genetic-based control strategies in *D. suzukii*. Specifically, we aim to engineer *D. suzukii* gene drive strains that can be utilized to spread desirable genes (e.g., susceptibility to a novel bio-friendly pesticide) throughout, or to entirely suppress/eradicate, wild *D. suzukii* populations. Such an approach is catalytic, with release of only modest numbers of engineered insects required to spread desirable genes or achieve population suppression. Additionally, since such a system relies on only a few releases of transgenic insects to do the all of the work on an ongoing basis, it is cheap as compared to the use of insecticides, which need to be applied regularly. Finally, a major appeal of this approach is that it is environmentally friendly and entirely insect-specific, and would have no effect on crops or on beneficial organisms.

Objectives for the next fiscal year (2018-2019)

- **Suppression approach one**: Previously, we have described a functional population replacement system in *D. suzukii* termed *Medea*, and have shown that it is capable of working in diverse genetic backgrounds and of maintaining itself at high frequencies in a population [15]. We have now molecularly developed a second-generation optimized *Medea* system that can spread to fixation quickly and can be used to replace the first population should a recall ever be necessary, and are working on testing this system in flies (to be completed within a year). We are also working, in collaboration with the Montell Lab at UCSB, to test effector genes capable of bringing about conditional lethality in *D. melanogaster*, which should also be completed within a year. Once such genes are characterized, we can then link them with our optimized *Medea* system to generate a fully functional gene drive system capable of population suppression.
- **Suppression approach two:** We are also working on engineering a second type of suppression system termed Y-drive that relies on CRISPR/Cas9 to bias sex ratios by shredding the X chromosome, leading to an all-male population crash. We have already developed several components required to generate Y-drive: we have engineered multiple Cas9 strains, optimized transgenic gRNA designs, demonstrated efficient CRISPR/Cas9 function in *D. suzukii*, and developed a method to dock transgenes on the Y chromosome of flies[16]. We have also been testing X chromosome-targeting gRNAs in *D. melanogaster*. We now plan to combine these components to attempt to generate *D. suzukii* gRNA transgenes capable of shredding the X chromosome, and to express said transgenes from the Y chromosome.

Proposed Budget:

The total amount requested is **$80,000,** with $50,000 allocated to the first approach, and $30,000 allocated to the second approach. For <u>suppression approach one</u> (*Medea* system), 30% of the funds ($15,000) will to be utilized for postdoc salary and benefits, 20% ($10,000) will be used for molecular biology reagents for building and testing the various transgenes, 40% ($20,000) will be used for microinjections into *D. suzukii*, and 10% ($5,000) will be utilized for supplies/equipment for fly maintenance, etc. For <u>suppression approach two</u> (Y-drive), 30% of the funds ($9,000) will to be utilized for postdoc salary and benefits, 30% ($9,000) will be used for molecular biology reagents for building and testing the various transgenes, 30% ($9,000) will be used for microinjections into *D. suzukii*, and 10%

($3,000) will be utilized for supplies/equipment for fly maintenance, etc.

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15. Buchman, A. & Akbari, O. S. Site-specific transgenesis of the D. melanogaster Y-chromosome using CRISPR/Cas9. *Insect Mol. Biol.* (2018). doi:10.1111/imb.12528

BLUEBERRY EXPORT MARKETS

CA GROWN PARTNERSHIP

California Grown, also known as the Buy California Marketing Agreement (BCMA), is a joint e
agricultural industry groups representing the products of California'
Working as an advisory board to the California Department of Food and Agriculture, BCMA brings together industry and government resources to increase the awareness, consumption, and value of California agricultural products, helping the state's consumers enjoy the best of the California lifestyle.

California Grown is funded through public and private contributions by the U.S. Department of Agriculture, the California Department of Food and Agriculture, and California agricultural organizations.

The CBC participates as an active member of the California Grown partnership by attending regular board meetings and joining internal committees. Through this partnership, the CBC is able to promote California blueberries at various events including, California Agriculture Day at the Capitol, the Produce Marketing Association's Fresh Summit Exposition, and many more.

Additionally, since the CBC is an official member of CA Grown, all Commission and CA Blueberry industry members have the opportunity to use the CA Grown logo as they please. For a high-resolution version of this iconic license plate logo, please contact the CBC.

EXPORT & DOMESTIC MARKET OVERVIEW

The California Blueberry Commission has culminated the final export numbers for the 2017/2018 season. California exported a total of 6,479,694.30, slightly up from last year's 6,479,539.80 pounds of blueberries. California is one of the largest exporters of blueberries in the United States, and the California Blueberry Commission actively works to help maintain these necessary export markets.

Below is a list of the top five countries and U.S. states that California shipped to this season. Enclosed are general summaries that the California Blueberry Commission is actively involved in, in addition to a Japan market overview provided by Yamano and Associates, a Canadian market overview provided by R.E.P.S., Inc, and a Southeast Asia market overview provided by Lieu Marketing Associates.

Top Five Countries (pounds)	
1) Canada	**4,419,874.15**
2) Taiwan	**514,072.00**
3) Japan	**385,936.70**
4) Dubai	**133,225.80**
5) Hong Kong	**130,053.00**

Top Five U.S. States (pounds)	
1) California	**17,429,809.80**
2) Washington	**5,042,722.20**
3) Texas	**3,518,891.50**
4) Oregon	**2,400,282.95**
5) Illinois	**1,841,706.40**

JAPAN

In 2017-2018, the California Blueberry Commission continued its partnership with Yamano & Associates for another year. The CBC benefits significantly from its partnership with Yamano & Associates in receiving direct updates, market intelligence, and its performance measures in the Japanese market throughout the duration of the California blueberry season. Additionally, Yamano & Associates ensures the CBC has close contact with the Agriculture Trade Officer (ATO) based in the U.S. Embassy in Tokyo, who also shares information with the Japan Ministry of Agriculture. Yamano & Associates has built and maintained a close relationship with the ATO, which has served to benefit the CBC's activities as a result. Yamano & Associates has also assisted the CBC by handling all in-country information distribution and educational/promotional activities.

In 2018, the CBC and the California Cherry Advisory Board (CCAB) engaged in a partnership to facilitate a Specialty Crop Block Grant program designed to jointly promote California Blueberries and California Cherries. This promotional campaign was suggested years ago by many of the Japanese retailers and importers, and the CBC and the CCAB coordinated the promotional campaign with each other to target retailers and importers that were carrying both products at the same time. Yamano & Associates served as the point agency handling all in-country coordination, information, and distribution of the marketing materials. The campaign was met with very positive enthusiasm, however, the unfortunate limited cherry crop, coupled with decreased blueberry production, caused the promotion to fall short of its anticipated success. Although the campaign did generate positive interest from the retailers, the volume from both commodities was not sufficent to maintain active participation. The CBC and CCAB are actively searching for an additional means of funding to continue this promotion campaign next year, and have applied for funding through the newly announced Foreign Agricultural Trade Promotion (ATP) funding program designed to offset current trade barriers. Furthermore, the CBC has and will continue to coordinate all promotions with the US Highbush Bleuberry Council to avoid any duplication of efforts. This has enabled the USHBC to utilize more funds in specific areas which enhanced the blueberry marketing campaign in Japan.

In 2017-2018, California saw a decrease in the volume of blueberries exported to Japan from 484,568.40 to 374,907.90 pounds. This decrease in exports can be attributed to this year's decrease in blueberry production; however, since the decrease was only 22%, this is an indicator of future success for blueberries in the Japanese market. During the 2018 season, there were zero MRL and pest violations while exporting to Japan. Should there ever be a violation, the CBC has instituted an alert system through the Blueberry Marketing Resource and Information Center (BMRIC) that is designed to notify industry members regarding any pertinent and time sensitive issues that may arise during the season.

Additionally, Mr. Jeff Zimmerman has been transferred to serve as the ATO director in Osaka, Japan from his previous post in Canada. This is excellent news as the CBC has established an outstanding relationship with Mr. Zimmerman.

Finally, as trade negotiations continue between the United States and other countries, the CBC will continue to be involved and comment on discussions. The following pages include the annual report provided by Yamano & Associates detailing the activities they conducted in 2018 on behalf of the California blueberry industry.

California Blueberry Commission
2018 Japanese Market Report

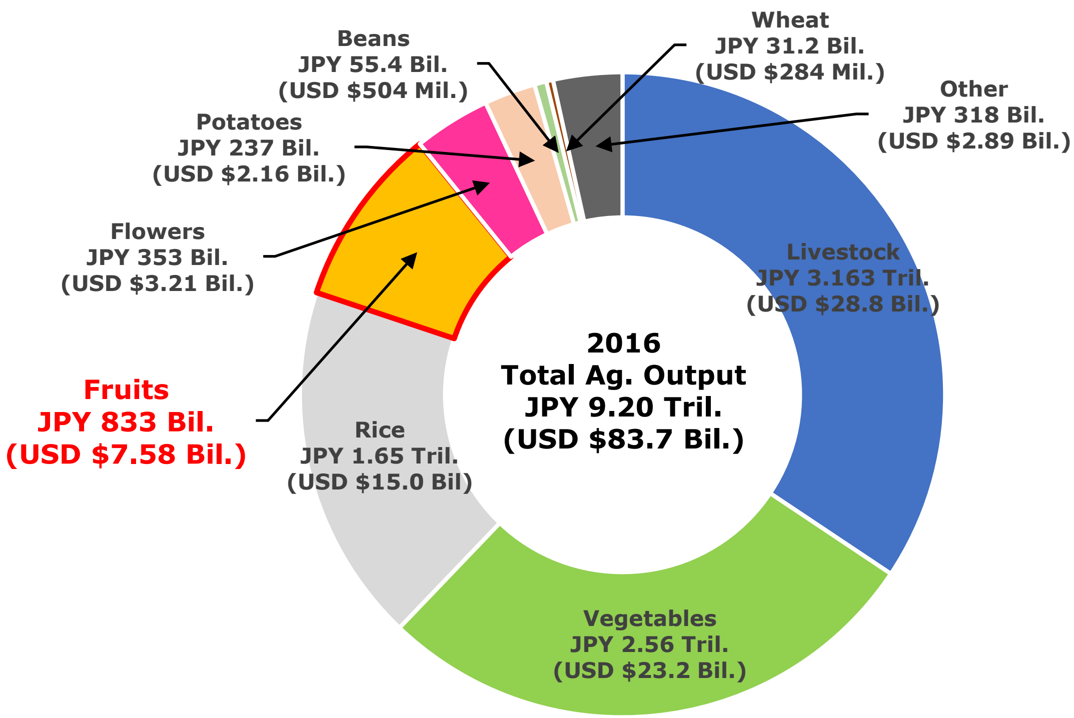
Yamano & Associates
Tokyo, Japan

September, 2018

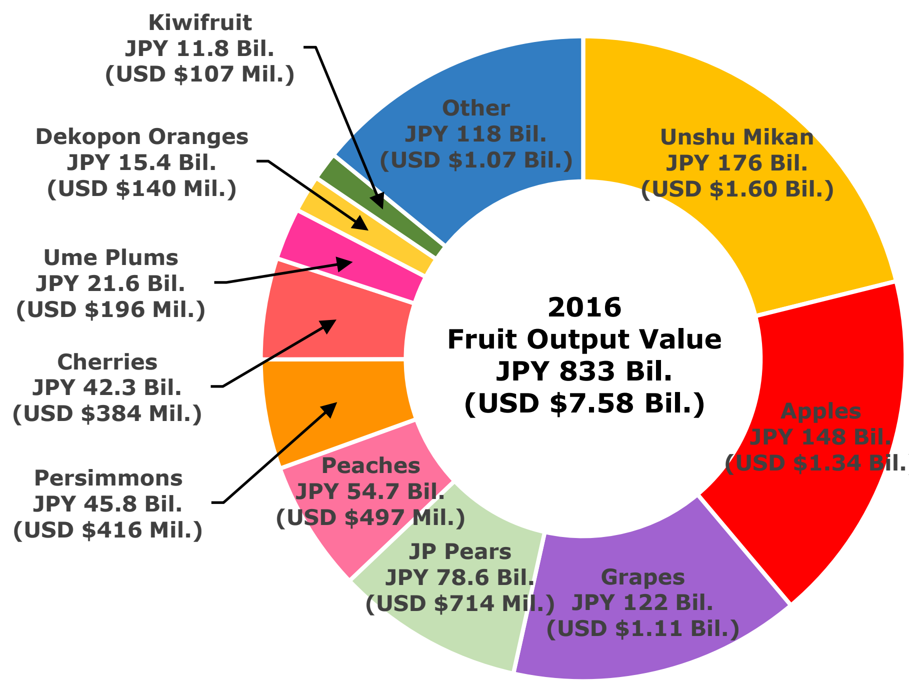
Agriculture in Japan

Despite rapid aging of the society and shrinking population, total agricultural output in 2016 grew 4.60% from 2015 to JPY 9.20 Trillion (USD $83.7 Billion). Output value of fruits also grew in 2016, recording 6.32% increase from 2015 to JPY 833 Bil. (USD $7.58 Bil.). This figure does not include strawberries, melons and watermelons, which are classified as "fruit-like vegetables" by the Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF).

Total Agricultural Output in Japan (2016)



Output Value of Fruits by Commodity Type (2016)



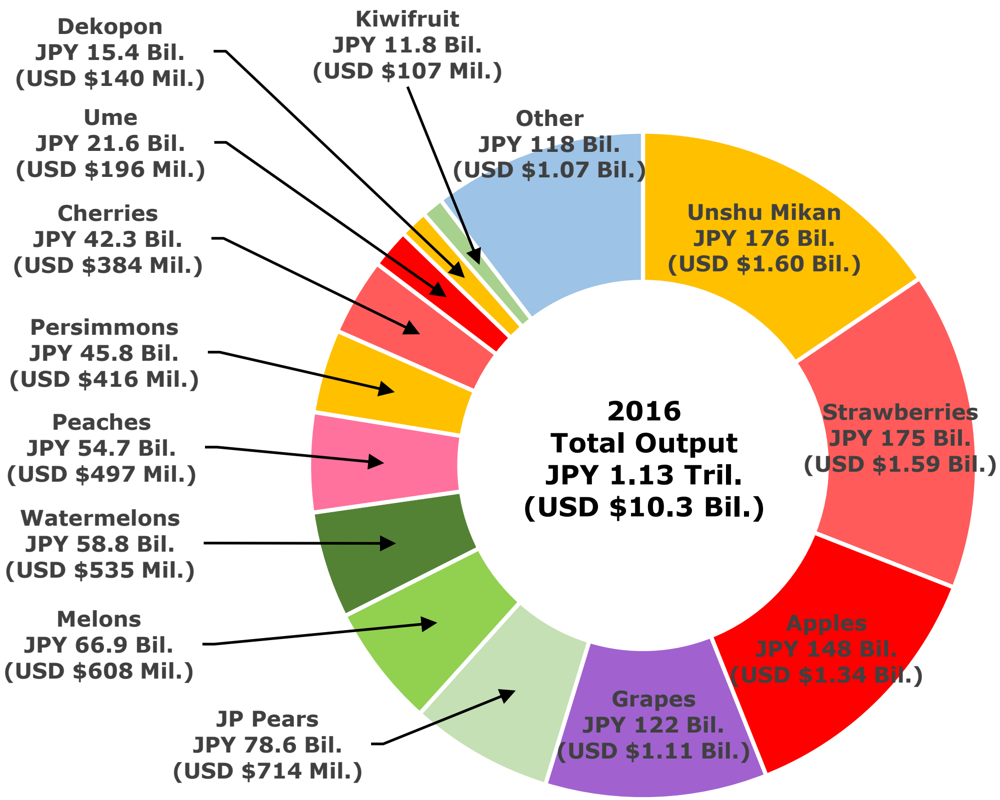
Data Sources: Situation Surrounding Fruits report, MAFF, Jul. 2018 and 2016 Agricultural Income Statistics

Agriculture in Japan

Unshu mikan and apples are the two top fruits* in Japan in terms of volume, followed by watermelons, Japanese pears and persimmons. In terms of value, the top five players are the unshu mikan, strawberries, apples, grapes and Japanese pears. Domestics blueberries had production volume of 2,547 metric tons.

*including fruit-like vegetables

Output value of fruits with major fruit-like veg. added (2016)



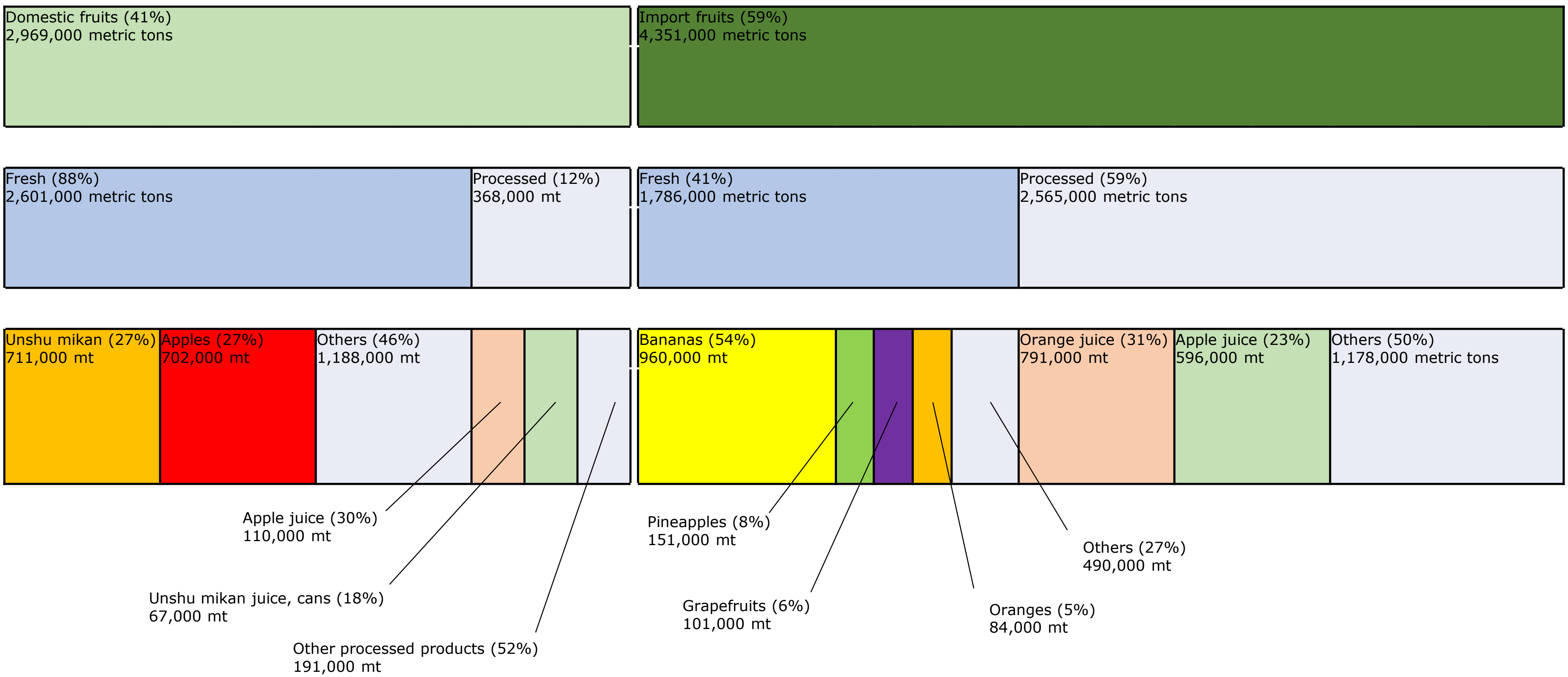
Rank*	Commodity	Output Val. (Mil.)	Output Vol. (Tons)
1 (8)	Mikan	176,100	805,100
2 (9)	Strawberries*1	174,900	159,000
3 (13)	Apples	147,700	765,000
4 (16)	Grapes	121,800	179,200
5 (23)	Japanese Pears	78,600	247,100
6 (27)	Melons*1	66,900	158,200
7 (29)	Watermelons*1	58,800	344,800
8 (30)	Peaches	54,700	127,300
9 (35)	Persimmons	45,800	232,900
10 (36)	Cherries	42,300	19,800
11 (60)	Ume	21,600	92,700
12 (66)	Dekopon Oranges	15,400	42,150 (‘15)
13 (72)	Kiwifruit	11,800	25,600
14 (86)	Japanese plums	8,500	23,000
15 (87)	Mangoes	8,100	3,805 (‘15)
16 (91)	Figs	7,000	13,576 (‘15)
17 (99)	Summer Oranges	5,700	36,497 (‘15)
18 (102)	Iyokan	5,500	36,799 (‘15)
19 (107)	Hassaku	4,700	36,073 (‘15)
20 (109)	Ponkan	4,700	21,500 (‘15)
	Blueberries	-	2,547 (‘15)

Data Sources: 2015, 2016 Fruit Production and Shipment Statistics, 2016 Agricultural Income Statistics, MAFF

Japanese Fruit Market Overview

According to the July 2018 report by Japan Ministry of Agriculture, Forestry and Fisheries, domestic demand for fruits consisted of 41% domestic and 59% import fruits. Of domestically produced fruits, 88%, or 2.6 million tons, were destined for fresh consumption versus 12%, or 368,000 tons, for processing. For import fruits, the ratio of fruits labeled for processing was much higher at 59% of 2.57 million tons.

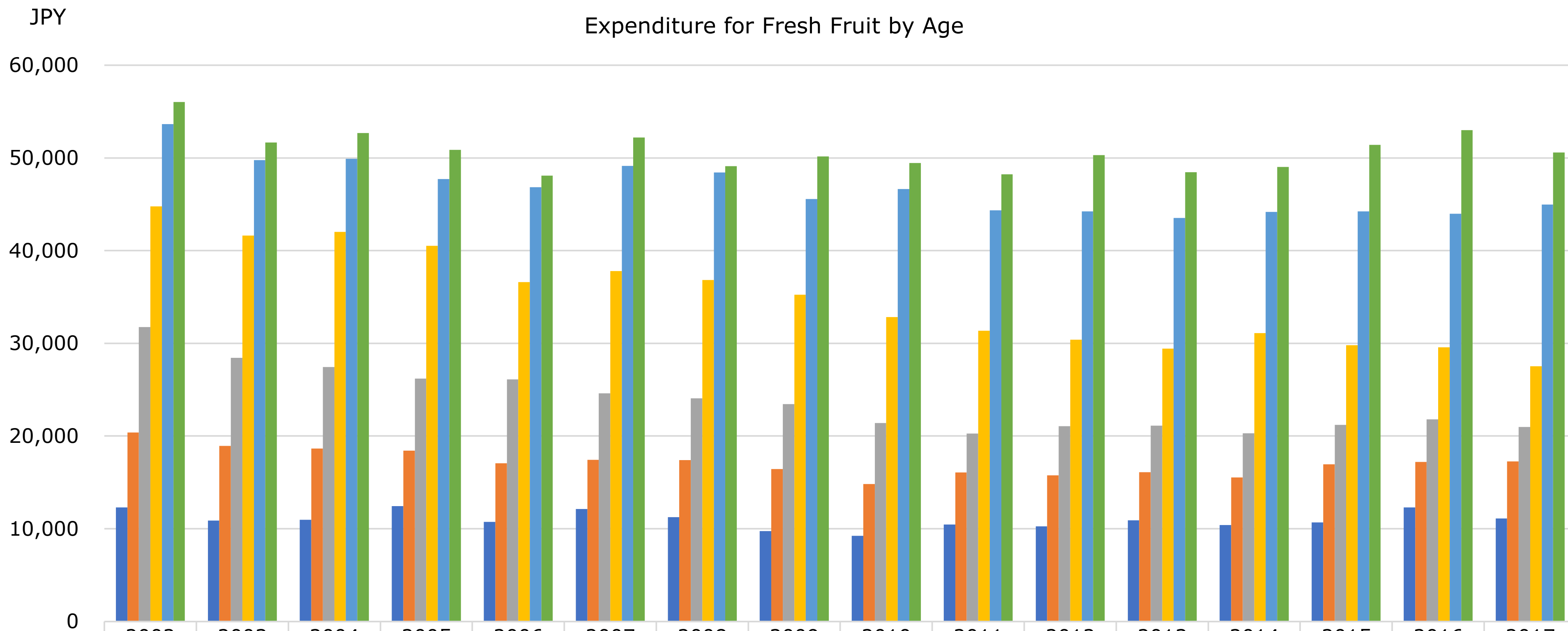
Bananas were top imported fruits, accounting for 54% of all imported fruits. Approximately 50% of fruits imported for processing was either for orange or apple juices.



2018 Situation Surrouding Fruits Report by Japan Minstry of Agriculture, Forestry and Fisheries

Fresh Fruit Consumption by Age

The average expenditures for fresh fruits markedly decreased for all age groups in the last 15 years. The drops were most visible in the middle-age brackets of 40s and 50s. For consumers in the 40 – 49 age bracket, the expenditure declined nearly 35% from JPY 31,766 in 2002 to JPY 20,982 in 2017. For the 50 – 59 age group, the decrease was about 38.5% sliding from JPY 44,768 in 2002 to JPY 27,542 in 2017.

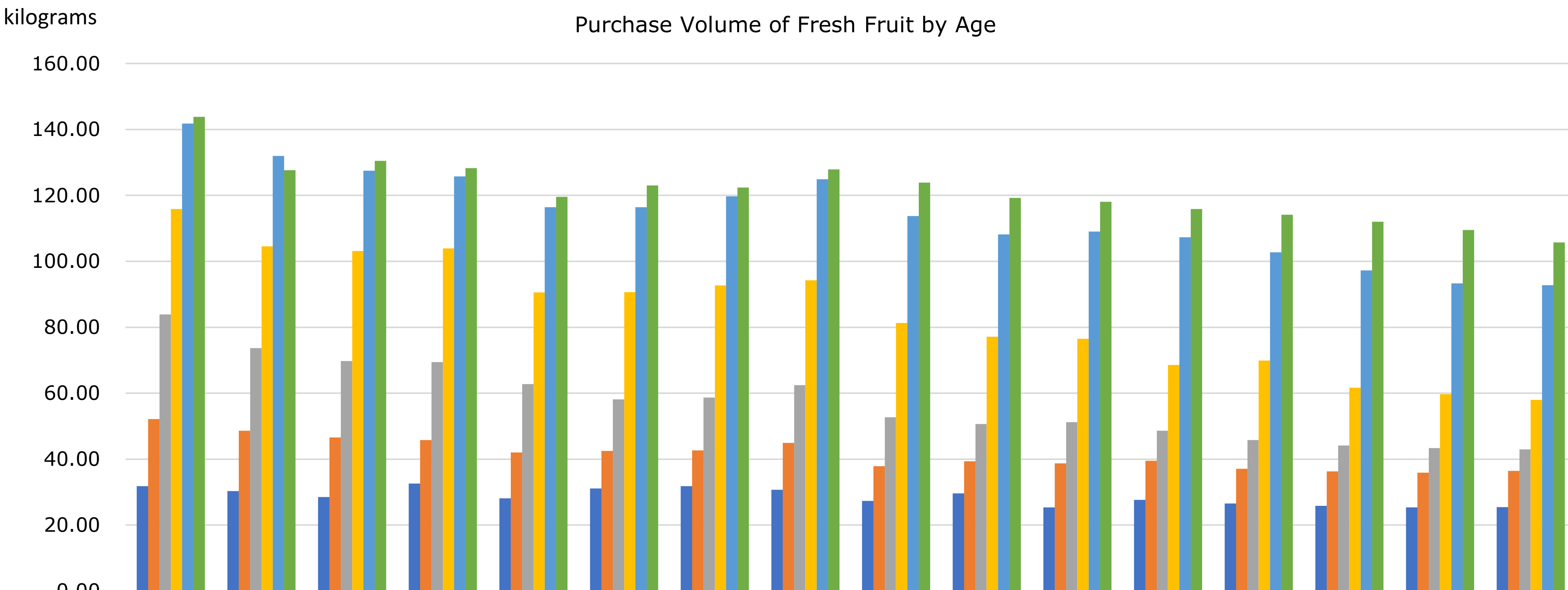


	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Under 29	12,312	10,875	10,973	12,446	10,750	12,119	11,258	9,744	9,248	10,458	10,258	10,916	10,404	10,673	12,295	11,098
30 - 39	20,371	18,937	18,644	18,429	17,077	17,446	17,412	16,440	14,829	16,058	15,761	16,089	15,538	16,961	17,218	17,266
40 - 49	31,766	28,424	27,455	26,187	26,101	24,613	24,061	23,452	21,417	20,280	21,052	21,110	20,306	21,204	21,790	20,982
50 - 59	44,768	41,622	42,008	40,510	36,607	37,807	36,839	35,235	32,843	31,344	30,406	29,439	31,113	29,799	29,560	27,542
60 - 69	53,650	49,754	49,900	47,730	46,835	49,133	48,423	45,563	46,637	44,332	44,239	43,530	44,174	44,229	43,976	44,980
70+	56,030	51,652	52,678	50,861	48,102	52,212	49,114	50,160	49,443	48,222	50,314	48,454	49,015	51,401	53,008	50,595

Fresh Fruit Consumption by Age

Looking at the purchase amount of fresh fruits, the trends are similar, but decrease is more visible across the board. On average, the consumption dropped approximately 35%.

In all age groups, people are spending more per kilogram of fruits, spending, on average, JPY 480 per kilogram. The increase may be attributable to higher fruit prices and also to people purchasing more premium fruits.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Under 29	31.82	30.34	28.54	32.56	28.12	31.13	31.85	30.73	27.36	29.64	25.34	27.63	26.51	25.86	25.38	25.41
30 - 39	52.18	48.61	46.57	45.79	42.03	42.50	42.65	44.96	37.83	39.38	38.70	39.54	37.11	36.27	35.88	36.47
40 - 49	83.86	73.68	69.79	69.45	62.73	58.15	58.69	62.49	52.72	50.66	51.22	48.66	45.81	44.17	43.35	42.98
50 - 59	115.85	104.55	103.16	103.94	90.59	90.63	92.72	94.25	81.32	77.17	76.52	68.55	69.93	61.67	59.70	57.98
60 - 69	141.83	132.01	127.48	125.77	116.40	116.40	119.76	124.88	113.74	108.19	109.01	107.32	102.73	97.22	93.29	92.81
70+	143.85	127.64	130.47	128.29	119.56	123.06	122.40	127.92	123.89	119.22	118.06	115.89	114.14	112.05	109.54	105.76

Fresh Fruit Import to Japan

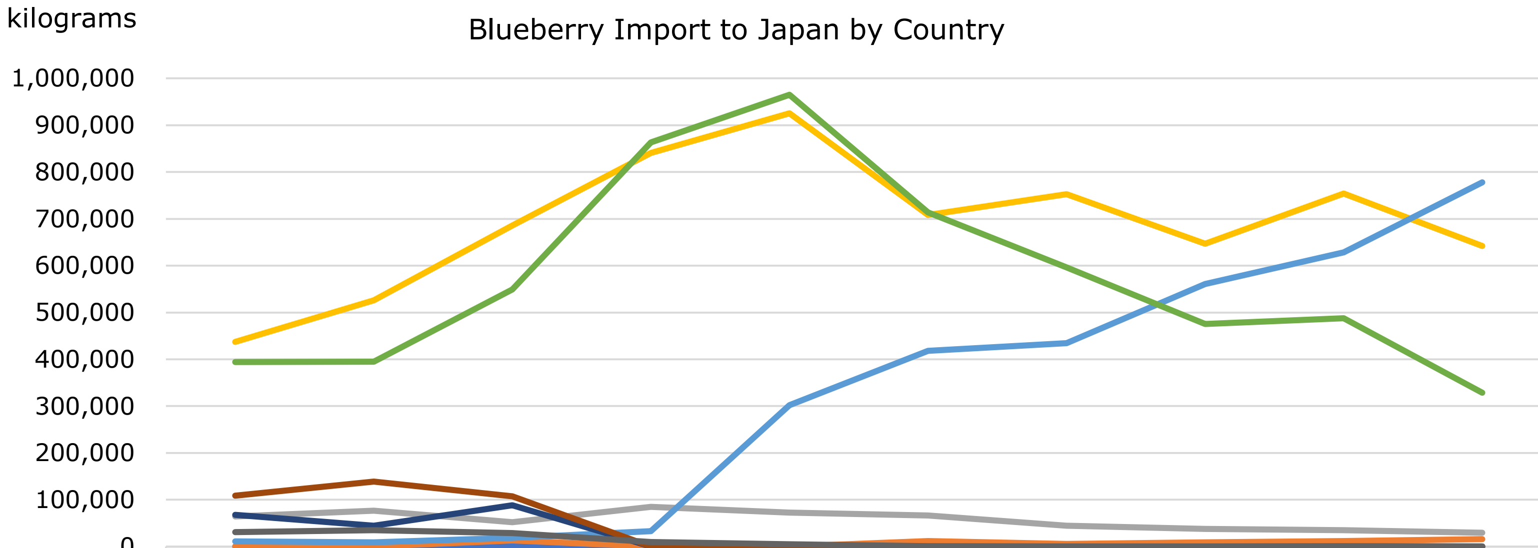
Although on a downward trend as with the rest of the fruit category, bananas are, by far, the most consumed of all imported fresh fruits in Japan with import volume of 9,84,195,818 kg or 2,171,984,987 lbs. in 2017. Blueberry import decreased approximately 6.5% to 1,794,709 kg or 3,956,656 lbs., valued at JPY 2,531,517,000.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Banana	1,092,738,078	1,252,605,803	1,109,072,184	1,064,124,885	1,086,189,401	974,791,795	946,204,506	958,800,104	956,113,921	985,195,818
Pineapple	144,464,356	143,981,460	142,582,468	152,863,934	174,025,277	181,182,260	166,295,211	150,598,021	143,146,576	156,962,226
Grapefruit	184,038,056	178,912,002	174,770,715	160,004,262	151,412,665	127,300,992	106,907,046	100,959,542	83,430,630	78,069,057
Orange	10,082,949	94,410,840	109,945,645	115,329,936	130,476,386	111,886,296	83,553,161	84,113,222	101,542,800	90,593,317
Avocado	24,072,644	29,840,144	44,552,422	37,172,510	58,554,502	60,457,552	57,599,512	57,588,047	73,914,772	60,635,120
Kiwifruit	59,221,620	58,500,529	62,962,844	65,894,753	63,970,012	58,747,147	65,061,181	78,647,999	93,191,986	92,981,379
Lemon	57,404,677	51,422,454	52,617,734	51,897,989	53,833,580	49,229,669	47,298,600	48,557,603	49,293,774	50,800,704
Melon	31,024,566	29,354,981	29,468,821	32,948,267	29,641,827	32,720,518	28,920,827	23,766,863	28,592,197	25,893,351
Raisin	30,484,319	27,252,362	30,453,851	29,590,828	28,692,281	30,373,414	29,593,868	31,938,216	32,077,291	38,103,394
Grape	6,612,208	7,549,510	12,625,452	15,409,596	21,405,549	22,759,498	19,717,466	21,915,050	33,671,355	31,318,819
Strawberry	3,277,838	2,992,356	3,258,597	3,395,044	3,508,553	3,517,079	3,354,179	3,072,705	2,991,738	3,175,960
Blueberry	1,113,509	1,224,940	1,546,534	1,832,928	2,270,712	1,919,269	1,834,154	1,730,015	1,918,328	1,794,709

	2008	2,009	2010	2011	2012	2013	2014	2015	2016	2017
Banana	85,440,236	94,420,259	74,398,208	71,999,005	70,807,343	79,536,033	85,645,369	101,900,716	100,306,351	94,976,788
Pineapple	10,288,209	10,347,412	9,804,095	10,142,077	11,352,873	11,491,551	12,381,586	13,183,729	13,772,691	14,034,681
Grapefruit	18,577,024	16,864,035	17,177,856	14,116,479	14,058,357	13,004,258	11,935,505	12,870,957	11,534,920	10,280,351
Orange	10,082,949	9,353,417	11,158,465	10,751,311	12,647,228	12,493,554	11,873,003	12,686,623	14,055,241	13,773,517
Avocado	7,599,039	7,690,332	10,578,640	10,507,671	12,916,664	15,817,220	17,830,413	18,576,428	22,961,994	23,013,601
Kiwifruit	19,420,275	19,668,266	21,045,802	21,045,528	21,899,763	20,460,112	22,211,493	27,225,017	31,182,422	34,940,112
Lemon	11,114,803	6,405,650	7,089,942	5,635,357	6,011,325	8,291,929	9,821,779	11,654,704	10,689,489	11,902,533
Melon	3,183,161	2,794,474	2,690,125	3,046,299	2,890,235	3,266,241	3,130,657	2,787,982	3,017,343	2,758,023
Raisin	6,719,469	5,384,389	6,459,031	7,189,112	7,512,774	9,322,840	9,288,661	11,308,286	9,772,966	10,217,086
Grape	1,609,433	1,599,900	2,754,247	3,499,708	5,024,136	6,000,930	5,522,249	6,948,469	10,717,018	9,996,852
Strawberry	3,321,444	2,660,010	2,666,262	2,729,653	2,891,207	3,382,098	3,436,376	3,534,714	2,929,120	3,404,013
Blueberry	1,599,676	1,462,291	1,760,039	1,875,345	2,302,832	2,434,343	2,444,258	2,686,890	2,652,908	2,531,517

Blueberry Import to Japan by Country

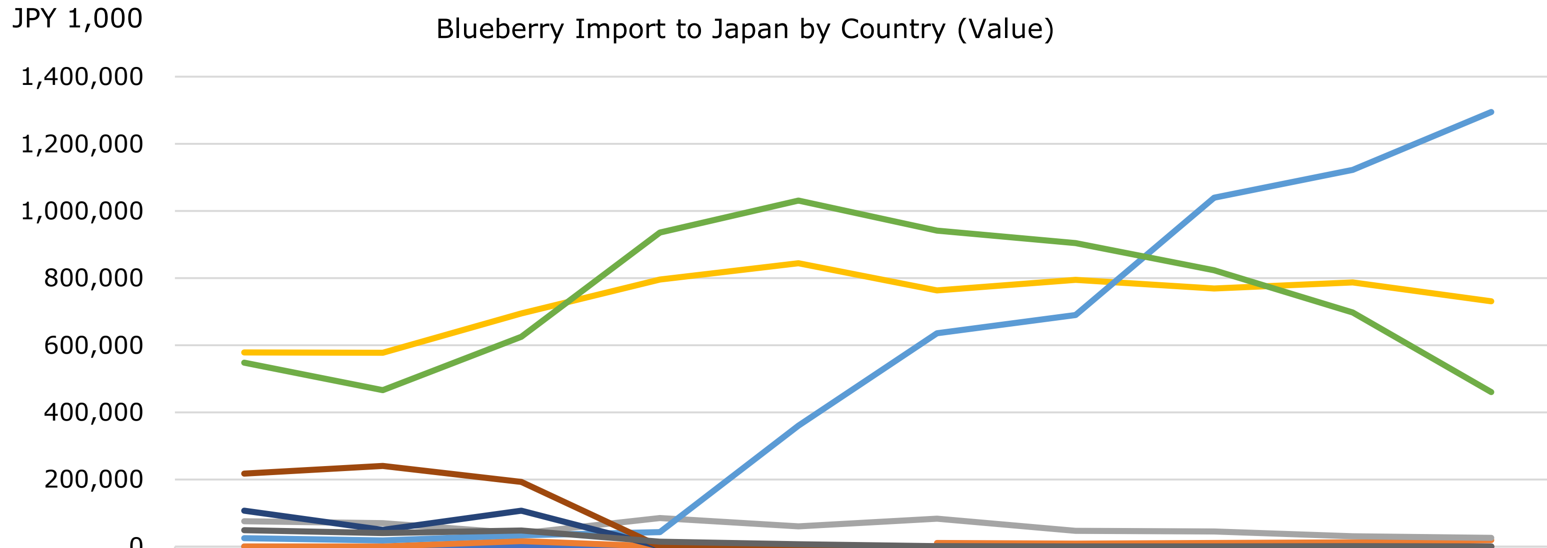
Blueberry import from Mexico has shown a dramatic increase in the recent years, starting in 2012, when import volume from that country showed 10-fold increase from 32,698 kg (72,087 lbs.) in 2011 to 301,967 kg (665,723 lbs.). Mexican blueberry import steadily increased since, surpassing Chile in 2015 and the U.S. in 2017 to become the largest import blueberry supplier for Japan.



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
South Korea	240	525	1,525	237	300	0	0	0	750	0
Poland	0	0	12,969	324	0	12,006	5,544	9,000	11,994	15,936
Canada	64,119	76,468	51,814	84,724	72,780	66,082	44,765	37,721	34,709	29,707
USA	436,931	525,831	685,904	840,903	925,482	708,570	752,751	646,984	754,381	641,769
Mexico	11,286	9,281	18,848	32,698	301,967	418,375	434,805	561,073	628,332	778,049
Chile	394,024	394,638	549,432	863,524	965,339	713,552	596,289	475,237	487,478	328,528
Argentina	67,834	44,519	88,427	0	0	0	0	0	0	0
Australia	108,501	138,911	107,111	0	0	0	0	0	0	0
New Zealand	30,574	34,767	29,028	9,864	4,844	684	0	0	684	0

Blueberry Import to Japan by Country

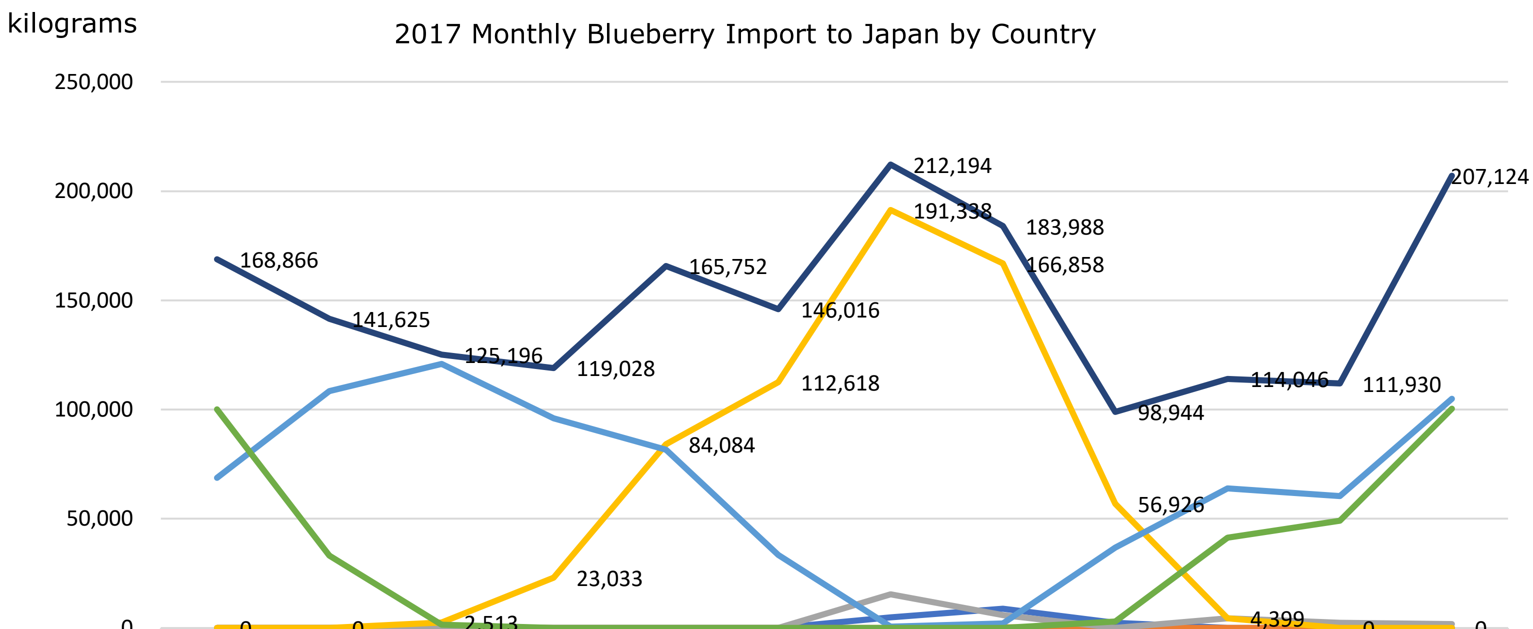
Mexico overtook the U.S. and Chile in 2015 to become the top blueberry exporting country to Japan in terms of value. In 2017, JPY 731,111,000 worth of blueberries came in from the U.S. (versus JPY 460,074,000 from Chile and JPY 1,294,672,000 from Mexico). The total value of U.S. blueberries roughly stayed the same in the last five years at the average of JPY 769,139,000.



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
South Korea	478	610	2,019	357	369	0	0	0	480	0
Poland	0	0	16,163	386		10,695	8,784	10,433	12,937	19,060
Canada	75,570	70,173	39,281	84,634	60,232	82,788	47,081	44,591	30,626	25,703
USA	578,422	577,300	694,624	796,138	843,974	762,944	794,716	769,325	787,601	731,111
Mexico	24,545	18,172	33,080	42,596	359,977	635,385	689,645	1,039,323	1,122,869	1,294,672
Chile	547,919	466,384	625,333	936,012	1,031,291	941,268	904,032	823,218	697,411	460,074
Argentina	106,473	49,904	106,678	0	0	0	0	0	0	0
Australia	217,224	239,976	192,866	0	0	0	0	0	0	0
New Zealand	49,045	39,772	47,827	14,458	6,989	1,263	0	0	984	0

2017 Monthly Blueberry Import to Japan by Country

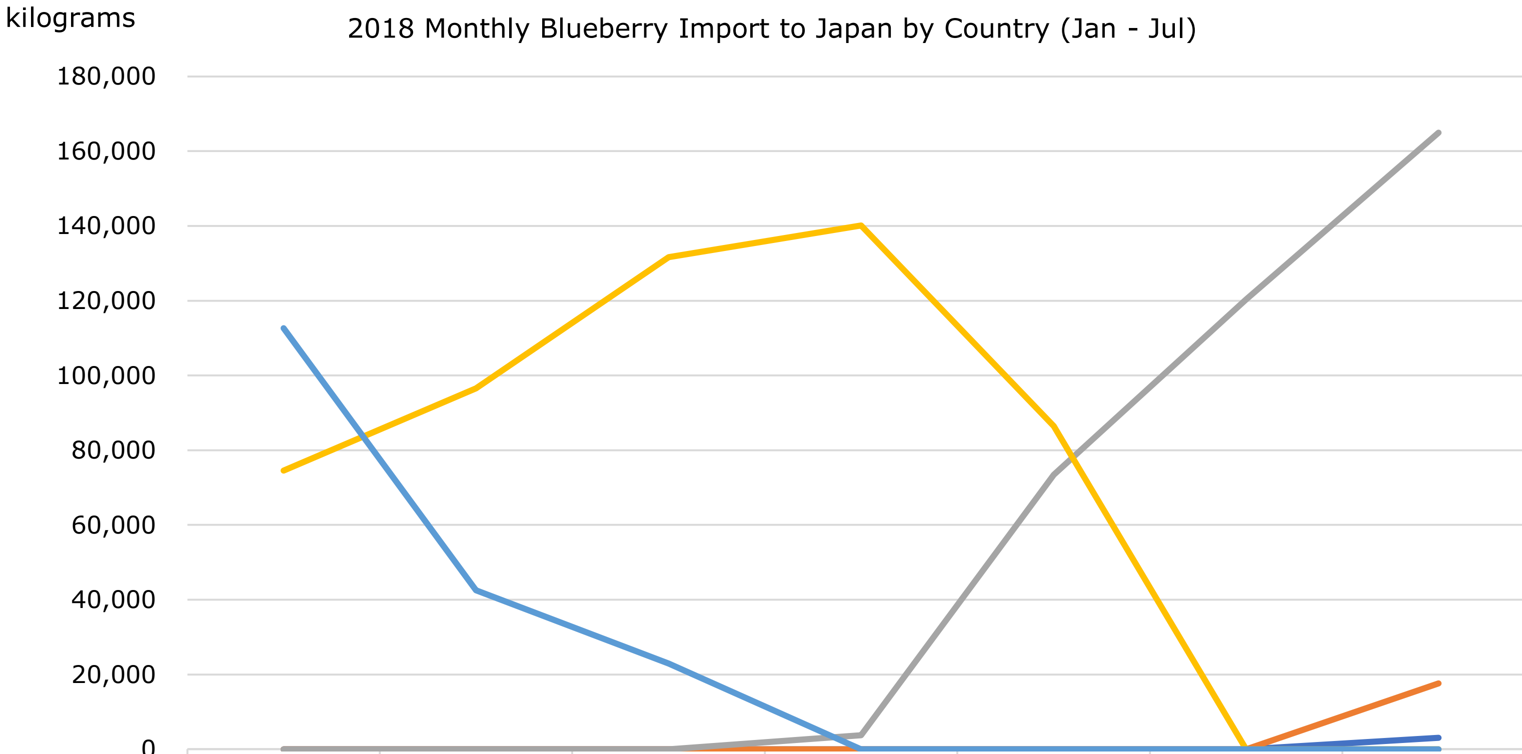
Between May and August, blueberries from the U.S. made up large percentages of import blueberries in Japan (50.7% in May, 77.1% in June, 90.2% in July and 90.7% in August). Mexican blueberries have the largest overlapping season with the U.S. blueberries. With domestic blueberries also available from early summer, Mexican and domestic blueberries are the biggest competitors for the U.S. blueberries.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Poland	0	0	0	0	0	0	4,800	8,832	2,304	0	0	0
Lithuania	0	0	360	0	0	0	0	360	0	0	0	0
Canada	0	0	0	0	0	0	15,424	5,824	0	4,378	2,381	1,700
USA	0	0	2,513	23,033	84,084	112,618	191,338	166,858	56,926	4,399	0	0
Mexico	68,753	108,506	120,855	95,995	81,668	33,398	632	2,114	36,780	63,965	60,407	104,976
Chile	100,113	33,119	1,468	0	0	0	0	0	2,934	41,304	49,142	100,448
Total	168,866	141,625	125,196	119,028	165,752	146,016	212,194	183,988	98,944	114,046	111,930	207,124

Monthly Blueberry Import to Japan by Country

Blueberry import from the U.S. is slightly slower in 2018 with import volume reaching just under 88% of the 2017 volume. Mexico, on the other hand, had a positive first half of the year, sending approximately 560 tons of blueberries by July.



	Jan	Feb	Mar	Apr	May	Jun	Jul
Poland	0	0	0	0	0	0	3,072
Canada	0	0	0	0	0	0	17,615
USA	0	0	0	3,743	73,456	120,321	164,965
Mexico	74,564	96,582	131,661	140,140	86,481	0	0
Chile	112,637	42,510	22,903	0	0	0	0

Domestic Blueberry Production

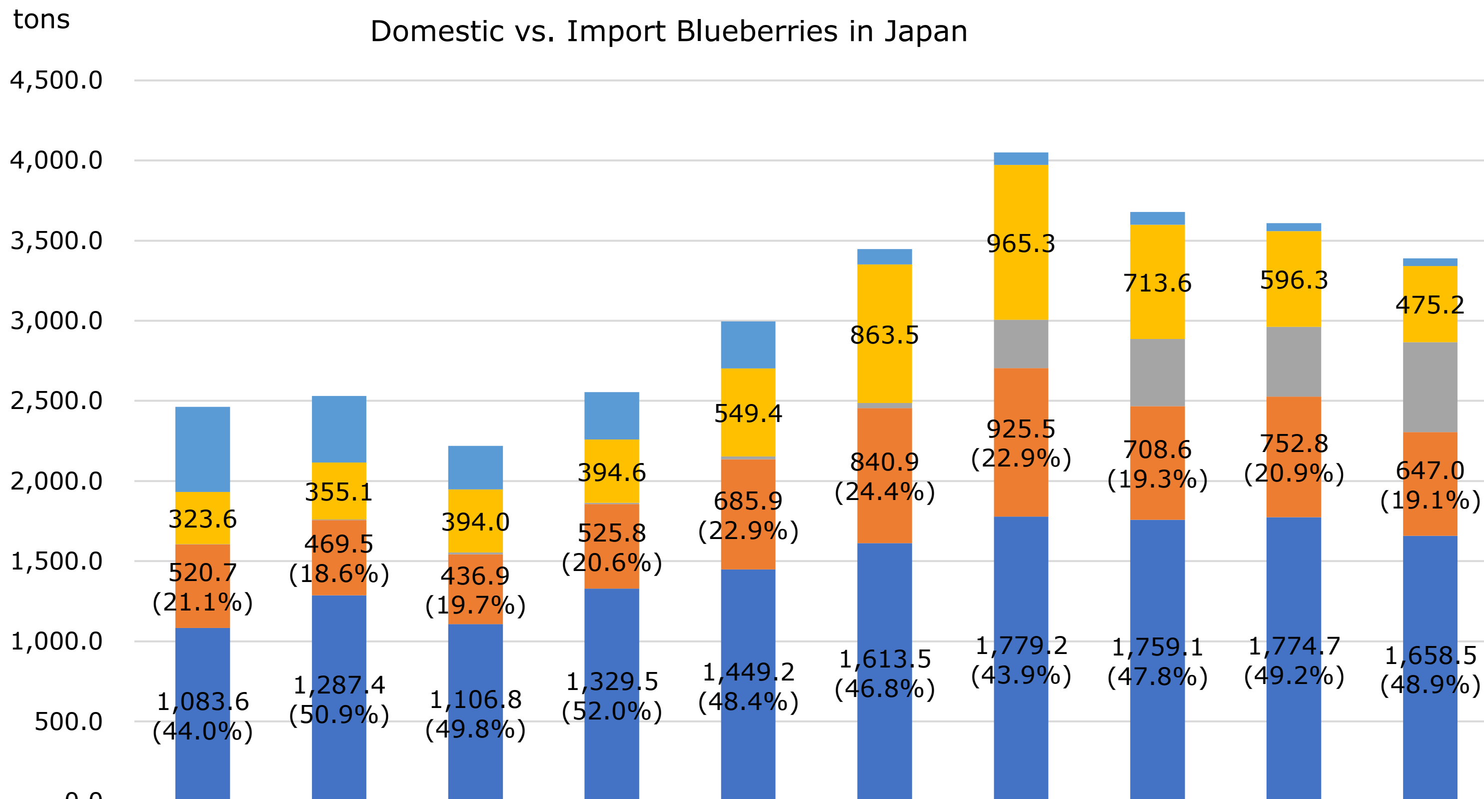
After about a decade of steady growth both in acreage and output, domestic blueberry production decreased for two years in a row in 2014 and 2015. After peaking at 1,132.9 hectares (2,799.5 acres) in 2013, the total acreage slipped slightly to 1,101.9 ha (2,722.9 acres) in 2015, with yield settling at 2547.4 tons or 5,616,000 lbs.

Tokyo took over as the top blueberry growing prefecture in Japan with production of about 313 tons. Nagano, which has been running as the number one blueberry producing area, slid to number three spot.

	Acreage (ha)	Yield (tons)	Shipment (tons)		Top Growing Prefectures (yield: tons)
			for fresh	for processing	
2006	787	1630	1083.6	302.1	Nagano(332), Gunma(144), Ibaraki(132)
2007	852.9	1808	1287.4	307.5	Nagano(351), Ibaraki (199), Tokyo (143)
2008	919.8	1872.4	1106.8	273.2	Nagano(426), Gunma(179), Tokyo(167)
2009	954.4	2215	1329.5	353.1	Nagano(432), Ibaraki(298), Gunma(214)
2010	1040.6	2258.5	1449.2	373.7	Nagano(467), Gunma(284), Tokyo(184)
2011	1041.1	2451.8	1613.5	398.6	Nagano(545), Gunma(282), Ibaraki(211)
2012	1126.7	2698.4	1779.2	448.6	Nagano(482), Tokyo(312), Gunma(299)
2013	1132.9	2700.1	1759.1	419.3	Nagano(444), Tokyo(377), Ibaraki(299)
2014	1110.8	2663.4	1774.7	472.9	Nagano(442), Tokyo(332), Ibaraki(297)
2015	1101.9	2547.4	1658.5	432.4	Tokyo (313), Ibaraki (304), Nagano (286)

Domestic vs. Import Blueberries on Japanese Market

Import blueberries account for approximately half of all fresh blueberries on the Japanese Market, with the US blueberries taking about 20% market share. In 2015, 1,730 metric tons, or 3,810,000 lbs. of blueberries were brought in from overseas.



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Other Origins	531.6	415.5	271.3	295.2	292.4	95.8	77.9	78.7	50.3	46.7
Chile	323.6	355.1	394.0	394.6	549.4	863.5	965.3	713.6	596.3	475.2
Mexico	3.2	2.8	11.3	9.3	18.8	32.7	302.0	418.4	434.8	561.1
USA	520.7	469.5	436.9	525.8	685.9	840.9	925.5	708.6	752.8	647.0
Domestic (for fresh)	1,083.6	1,287.4	1,106.8	1,329.5	1,449.2	1,613.5	1,779.2	1,759.1	1,774.7	1,658.5

Blueberries in Retail

Week	Store	Town	City	Price	Size	Origin
1/7 – 1/13	Life	Kanda Izumicho	Tokyo	¥398	125 g	Chile
1/7 – 1/13	Life	Kanda Izumicho	Tokyo	¥698	550 mL	Chile
1/7 – 1/13	Life	Kanda Izumicho	Tokyo	¥398	125 g	Chile
1/28 – 2/3	Life	Kanda Izumicho	Tokyo	¥698	550 mL	Chile
2/11 – 2/17	Life	Kanda Izumicho	Tokyo	¥398	125 g	Chile
2/25 – 3/3	Life	Kanda Izumicho	Tokyo	¥398	125 g	Chile
2/25 – 3/3	Life	Kanda Izumicho	Tokyo	¥698	310 g	Chile
3/4 - 3/10	Life	Kanda Izumicho	Tokyo	¥398	125 g	Mexico
3/18 – 3/24	Life	Kanda Izumicho	Tokyo	¥398	125 g	Mexico
3/25 – 3/31	Life	Kanda Izumicho	Tokyo	¥398	125 g	Mexico
4/1 – 4/7	Maruetsu Petit	Ichigaya	Tokyo	¥498	125 g	Mexico
4/1 – 4/7	Life	Kanda Izumicho	Tokyo	¥398	125 g	Mexico
4/15 – 4/21	Life	Kanda Izumicho	Tokyo	¥398	125 g	Mexico
4/15 – 4/21	Odakyu OX	Umegaoka	Tokyo	¥398	125 g	Mexico
4/15 – 4/21	Odakyu OX	Umegaoka	Tokyo	¥698		Japan
4/15 – 4/21	Queen's Isetan	Shinagawa	Tokyo	¥798		Japan
4/15 – 4/21	National Azabu	Hiroo	Tokyo	¥1280		Mexico
4/22 – 4/28	Y's	Umegaoka	Tokyo	¥498	125 g	Mexico
4/22 – 4/28	Odakyu OX	Umegaoka	Tokyo	¥398	125 g	Mexico
4/22 – 4/28	Odakyu OX	Umegaoka	Tokyo	¥698		Japan
4/22 – 4/28	Odakyu OX	Kyodo	Tokyo	¥498	125 g	Mexico
4/22 – 4/28	Summit	Umegaoka	Tokyo	¥398	125 g	Mexico
4/29 – 5/5	Odakyu OX	Umegaoka	Tokyo	¥398	125 g	Mexico
4/29 – 5/5	Odakyu OX	Umegaoka	Tokyo	¥698		Japan
4/29 – 5/5	Odakyu OX	Kyodo	Tokyo	¥498		Mexico
4/29 – 5/5	Y's	Umegaoka	Tokyo	¥498	125 g	Mexico

Blueberries in Retail

Week	Store	Town	City	Price	Size	Origin
4/29 – 5/5	Summit	Umegaoka	Tokyo	¥398	125 g	Mexico
4/29 – 5/5	Daimaru	Tokyo	Tokyo	¥756	125 g	Mexico
4/29 – 5/5	Presse Premium	Akasaka	Tokyo	¥498	125 g	Mexico
5/6 – 5/12	Odakyu OX	Umegaoka	Tokyo	¥398	125 g	Mexico
5/6 – 5/12	Odakyu OX	Umegaoka	Tokyo	¥698		Japan
5/6 – 5/12	Y’s	Umegaoka	Tokyo	¥498	125 g	Mexico
5/6 – 5/12	Summit	Umegaoka	Tokyo	¥398	125 g	Mexico
5/6 – 5/12	Life	Kanda Izumicho	Tokyo	¥698	311 g	California
5/13 – 5/19	Peacock	Kyodo	Tokyo	¥498	125 g	Mexico
5/13 – 5/19	Summit	Umegaoka	Tokyo	¥358	125 g	California
5/13 – 5/19	Summit	Umegaoka	Tokyo	¥498	125 g	Japan
5/13 – 5/19	Odakyu OX	Umegaoka	Tokyo	¥498	125 g	Mexico
5/13 – 5/19	Odakyu OX	Umegaoka	Tokyo	¥498		Japan
5/13 – 5/19	Odakyu OX	Kyodo	Tokyo	¥498		Japan
5/13 – 5/19	Odakyu OX	Seijo	Tokyo	¥498		Japan
5/13 – 5/19	Y’s	Umegaoka	Tokyo	¥498	125 g	Mexico
5/13 – 5/19	Summit	Umegaoka	Tokyo	¥358	125 g	California
5/13 – 5/19	Summit	Umegaoka	Tokyo	¥498		Japan
5/13 – 5/19	Peacock	Kyodo	Tokyo	¥498	125 g	Mexico
5/13 – 5/19	Tsuruya	Karuizawa	Nagano	¥369		California
5/13 – 5/19	Life	Kanda Izumicho	Tokyo	¥698	310 g	California
5/20 – 5/26	Odakyu OX	Umegaoka	Tokyo	¥498	125 g	Mexico
5/20 – 5/26	Odakyu OX	Umegaoka	Tokyo	¥598		Japan
5/20 – 5/26	Odakyu OX	Kyodo	Tokyo	¥498		Japan
5/20 – 5/26	Odakyu OX	Seijo	Tokyo	¥598		Japan
5/20 – 5/26	Y’s	Umegaoka	Tokyo	¥498	125 g	Mexico

Blueberries in Retail

Week	Store	Town	City	Price	Size	Origin
5/20 – 5/26	Seijo Ishii	Seijo Gakuen	Tokyo	¥399	125 g	California
5/20 – 5/26	Delicia	Karuizawa	Nagano	¥498	125 g	Mexico
5/20 – 5/26	Tsuruya	Karuizawa	Nagano	¥369	125 g	California
5/27 – 6/2	Tokyu Store	Gakugei Daigaku	Tokyo	¥680		Japan
5/27 – 6/2	Odakyu OX	Umegaoka	Tokyo	¥498	125 g	Mexico
5/27 – 6/2	Odakyu OX	Umegaoka	Tokyo	¥498		Japan
5/27 – 6/2	Odakyu OX	Kyodo	Tokyo	¥498		Japan
5/27 – 6/2	Y’s	Umegaoka	Tokyo	¥498	125 g	Mexico
5/27 – 6/2	Summit	Umegaoka	Tokyo	¥358	125 g	California
5/27 – 6/2	Summit	Umegaoka	Tokyo	¥498		Japan
5/27 – 6/2	Peacock	Kyodo	Tokyo	¥498	125 g	Mexico
5/27 – 6/2	Kinokuniya	Aoyama	Tokyo	¥2500	1 kg	California
5/27 – 6/2	Kinokuniya	Aoyama	Tokyo	¥1780	650 g	California
5/27 – 6/2	Kinokuniya	Aoyama	Tokyo	¥1480	500 g	California
5/27 – 6/2	Kinokuniya	Aoyama	Tokyo	¥1080	311 g	California
5/27 – 6/2	Kinokuniya	Aoyama	Tokyo	¥980	280 g	California
5/27 – 6/2	Lincos	Roppongi	Tokyo	¥498	125 g	Mexico
5/27 – 6/2	Lincos	Roppongi	Tokyo	¥680	Pack	Japan
5/27 – 6/2	Seijo Ishii	Akasaka	Tokyo	¥399	125 g	California
5/27 – 6/2	Life	Kanda Izumicho	Tokyo	¥398	125 g	California
5/27 – 6/2	Life	Kanda Izumicho	Tokyo	¥698	311 g	California
5/27 – 6/2	Summit	Fukasawa Sakaue	Tokyo	¥358	125 g	California
5/27 – 6/2	Summit	Fukasawa Sakaue	Tokyo	¥780	311 g	California

Blueberries in Retail

Week	Store	Town	City	Price	Size	Origin
5/27 – 6/2	Summit	Nozawa Ryuunji	Tokyo	¥358	125 g	California
5/27 – 6/2	Summit	Nozawa Ryuunji	Tokyo	¥780	311 g	California
5/27 – 6/2	Summit	Nozawa Ryuunji	Tokyo	¥498		Japan
5/27 - 6/2	Presse Premium	Tokyo Midland	Tokyo	¥498	125 g	Mexico
6/3 – 6/9	Summit	Magomezawa	Chiba	¥358	125 g	California
6/3 – 6/9	Summit	Magomezawa	Chiba	¥498		Japan
6/3 – 6/9	York Mart	Higashi Michinobe	Chiba	¥298	125 g	California
6/3 – 6/9	Maruetsu	Magomezawa	Chiba	¥498		Japan
6/3 – 6/9	Maruetsu	Magomezawa	Chiba	¥298	125 g	California
6/3 – 6/9	York Mart	Katsutadai	Chiba	¥298	Pack	California
6/3 – 6/9	Peacock	Yoga	Tokyo	¥398	125 g	Mexico
6/3 – 6/9	Tokyu Store	Gakugei Daigaku	Tokyo	¥580		Japan
6/3 – 6/9	A Coop	Kumejima	Okinawa	¥498		Japan
6/3 – 6/9	Life	Kanda Izumicho	Tokyo	¥398	125 g	California
6/3 – 6/9	Life	Kanda Izumicho	Tokyo	¥698	311 g	California
6/3 – 6/9	Life	Kanda Izumicho	Tokyo	¥398		Japan
6/3 – 6/9	Summit	Kinuta Kanpachidori	Tokyo	¥358	125 g	California
6/3 – 6/9	Summit	Kinuta Kanpachidori	Tokyo	¥780		California
6/3 – 6/9	Sakagami	Komagome	Tokyo	¥499		California
6/3 – 6/9	Summit	Seijo	Tokyo	¥358	Sml. Pack	California
6/3 – 6/9	Summit	Seijo	Tokyo	¥780	Lrg. Pack	California
6/3 – 6/9	Odakyu OX	Umegaoka	Tokyo	¥498	125 g	Mexico
6/3 – 6/9	Odakyu OX	Umegaoka	Tokyo	¥498		Japan
6/3 – 6/9	Odakyu OX	Kyodo	Tokyo	¥498	125 g	Mexico
6/3 – 6/9	Odakyu OX	Kyodo	Tokyo	¥498		Japan
6/3 – 6/9	Y’s	Umegaoka	Tokyo	¥498	125 g	California

Blueberries in Retail

Week	Store	Town	City	Price	Size	Origin
6/3 – 6/9	Summit	Umegaoka	Tokyo	¥358	125 g	California
6/3 – 6/9	Peacock	Kyodo	Tokyo	¥498	125 g	Mexico
6/10 – 6/16	Tokyu Store	Nozawa	Tokyo	¥580		Japan
6/10 – 6/16	Tokyu Store	Nozawa	Tokyo	¥498	125 g	Mexico
6/10 – 6/16	Seijo Ishii	Ebisu	Tokyo	¥458		California
6/10 – 6/16	York Mart	Sakura Josui	Tokyo	¥398	125 g	Chile
6/10 – 6/16	Odakyu OX	Umegaoka	Tokyo	¥498	125 g	Mexico
6/10 – 6/16	Odakyu OX	Umegaoka	Tokyo	¥498	125 g	Japan
6/10 – 6/16	Odakyu OX	Kyodo	Tokyo	¥498	125 g	Mexico
6/10 – 6/16	Odakyu OX	Kyodo	Tokyo	¥598	125 g	Japan
6/10 – 6/16	Y’s	Umegaoka	Tokyo	¥498	125 g	California
6/10 – 6/16	Summit	Umegaoka	Tokyo	¥358	125 g	California
6/10 – 6/16	Summit	Umegaoka	Tokyo	¥498	125 g	Japan
6/10 – 6/16	Peacock	Kyodo	Tokyo	¥498	125 g	Mexico
6/10 – 6/16	York Mart	Sakura Josui	Tokyo	¥398	125 g	Chile
6/17 – 6/23	Odakyu OX	Umegaoka	Tokyo	¥498	125 g	Mexico
6/17 – 6/23	Odakyu OX	Umegaoka	Tokyo	¥498		Japan
6/17 – 6/23	Odakyu OX	Kyodo	Tokyo	¥498	125 g	Mexico
6/17 – 6/23	Odakyu OX	Kyodo	Tokyo	¥598		Japan
6/17 – 6/23	Y’s	Umegaoka	Tokyo	¥498	125 g	California
6/17 – 6/23	Summit	Umegaoka	Tokyo	¥358	125 g	California
6/17 – 6/23	Summit	Umegaoka	Tokyo	¥498		Japan
6/17 – 6/23	Peacock	Kyodo	Tokyo	¥498	125 g	Mexico
6/17 – 6/23	York Mart	Sakura Josui	Tokyo	¥398	125 g	Chile
6/17 – 6/23	Life	Kanda Izumicho	Tokyo	¥398	125 g	California
6/17 – 6/23	Life	Kanda Izumicho	Tokyo	¥698	311 g	California

Blueberries in Retail

Week	Store	Town	City	Price	Size	Origin
6/24 – 6/30	Odakyu OX	Umegaoka	Tokyo	¥498	125 g	Mexico
6/24 – 6/30	Odakyu OX	Umegaoka	Tokyo	¥498		Japan
6/24 – 6/30	Odakyu OX	Kyodo	Tokyo	¥498	125 g	Mexico
6/24 – 6/30	Odakyu OX	Kyodo	Tokyo	¥598		Japan
6/24 – 6/30	Y’s	Umegaoka	Tokyo	¥498	125 g	California
6/24 – 6/30	Summit	Umegaoka	Tokyo	¥358	125 g	California
6/24 – 6/30	Summit	Umegaoka	Tokyo	¥498		Japan
6/24 – 6/30	Peacock	Kyodo	Tokyo	¥498	125 g	Mexico
7/1 – 7/7	Odakyu OX	Umegaoka	Tokyo	¥498	125 g	Mexico
7/1 – 7/7	Odakyu OX	Umegaoka	Tokyo	¥498		Japan
7/1 – 7/7	Odakyu OX	Kyodo	Tokyo	¥498	125 g	Mexico
7/1 – 7/7	Odakyu OX	Kyodo	Tokyo	¥598		Japan
7/1 – 7/7	Y’s	Umegaoka	Tokyo	¥498	125 g	Oregon
7/1 – 7/7	Y’s	Umegaoka	Tokyo	¥298		Japan
7/1 – 7/7	Summit	Umegaoka	Tokyo	¥358	125 g	California
7/1 – 7/7	Summit	Umegaoka	Tokyo	¥498		Japan
7/1 – 7/7	Peacock	Kyodo	Tokyo	¥498	125 g	Mexico
7/8 – 7/14	Odakyu OX	Umegaoka	Tokyo	¥398	125 g	Oregon
7/8 – 7/14	Odakyu OX	Umegaoka	Tokyo	¥398		Japan
7/8 – 7/14	Odakyu OX	Kyodo	Tokyo	¥498	125 g	Oregon
7/8 – 7/14	Odakyu OX	Kyodo	Tokyo	¥798	11 oz	Oregon
7/8 – 7/14	Odakyu OX	Kyodo	Tokyo	¥1980	32 oz	Oregon
7/8 – 7/14	Odakyu OX	Kyodo	Tokyo	¥358		Japan
7/8 – 7/14	Odakyu OX	Kyodo	Tokyo	¥598		Japan
7/8 – 7/14	Odakyu OX	Kyodo	Tokyo	¥698		Japan
7/8 – 7/14	Y’s	Umegaoka	Tokyo	¥498	125 g	Oregon

Blueberries in Retail

Week	Store	Town	City	Price	Size	Origin
7/8 – 7/14	Y’s	Umegaoka	Tokyo	¥298		Japan
7/8 – 7/14	Summit	Umegaoka	Tokyo	¥358	125 g	California
7/8 – 7/14	Summit	Umegaoka	Tokyo	¥398		Japan
7/8 – 7/14	Peacock	Kyodo	Tokyo	¥498	125 g	Mexico
7/8 – 7/14	Peacock	Kyodo	Tokyo	¥498		Japan
7/8 – 7/14	Peacock	Kyodo	Tokyo	¥258		Japan
7/15 – 7/21	Life	Kanda Izumicho	Tokyo	¥398	125 g	Oregon
7/15 – 7/21	Life	Kanda Izumicho	Tokyo	¥698	311 g	Oregon
7/15 – 7/21	Life	Kanda Izumicho	Tokyo	¥298		Japan
7/15 – 7/21	Odakyu OX	Umegaoka	Tokyo	¥398	125 g	Oregon
7/15 – 7/21	Odakyu OX	Umegaoka	Tokyo	¥398		Japan
7/15 – 7/21	Odakyu OX	Kyodo	Tokyo	¥798	11 oz	Oregon
7/15 – 7/21	Odakyu OX	Kyodo	Tokyo	¥598		Japan
7/15 – 7/21	Y’s	Umegaoka	Tokyo	¥498	125 g	Oregon
7/15 – 7/21	Y’s	Umegaoka	Tokyo	¥298		Japan
7/15 – 7/21	Summit	Umegaoka	Tokyo	¥358	125 g	California
7/15 – 7/21	Summit	Umegaoka	Tokyo	¥398		Japan
7/15 – 7/21	Peacock	Kyodo	Tokyo	¥498	125 g	Mexico
7/15 – 7/21	Peacock	Kyodo	Tokyo	¥498		Japan
7/22 – 7/28	Seijo Ishii	Kakinokizaka	Tokyo	¥690	500 g	Oregon
7/22 – 7/28	Odakyu OX	Umegaoka	Tokyo	¥398	125 g	Oregon
7/22 – 7/28	Odakyu OX	Umegaoka	Tokyo	¥398		Japan
7/22 – 7/28	Odakyu OX	Kyodo	Tokyo	¥798	11 oz	Oregon
7/22 – 7/28	Odakyu OX	Kyodo	Tokyo	¥598		Japan
7/22 – 7/28	Y’s	Umegaoka	Tokyo	¥498	125 g	Oregon

Blueberries in Retail

Week	Store	Town	City	Price	Size	Origin
7/22 – 7/28	Y's	Umegaoka	Tokyo	¥298		Japan
7/22 – 7/28	Summit	Umegaoka	Tokyo	¥358	125 g	Oregon
7/22 – 7/28	Summit	Umegaoka	Tokyo	¥398		Japan
7/22 – 7/28	Peacock	Kyodo	Tokyo	¥498	125 g	
7/22 – 7/28	Life	Kanda Izumicho	Tokyo	¥398	125 g	Oregon
7/22 – 7/28	Life	Kanda Izumicho	Tokyo	¥698	125 g	Oregon
7/29 – 8/4	Odakyu OX	Umegaoka	Tokyo	¥398	125 g	Oregon
7/29 – 8/4	Odakyu OX	Umegaoka	Tokyo	¥398		Japan
7/29 – 8/4	Odakyu OX	Kyodo	Tokyo	¥798	11 oz	Oregon
7/29 – 8/4	Odakyu OX	Kyodo	Tokyo	¥598		Japan
7/29 – 8/4	Odakyu OX	Kyodo	Tokyo	¥698		Japan
7/29 – 8/4	Y's	Umegaoka	Tokyo	¥498	125 g	Oregon
7/29 – 8/4	Y's	Umegaoka	Tokyo	¥298		Japan
7/29 – 8/4	Summit	Umegaoka	Tokyo	¥358	125 g	Oregon
7/29 – 8/4	Summit	Umegaoka	Tokyo	¥398		Japan
7/29 – 8/4	Peacock	Kyodo	Tokyo	¥498	125 g	
8/5 – 8/11	Odakyu OX	Umegaoka	Tokyo	¥398	125 g	Oregon
8/5 – 8/11	Odakyu OX	Umegaoka	Tokyo	¥398		Japan
8/5 – 8/11	Odakyu OX	Kyodo	Tokyo	¥798	11 oz	Oregon
8/5 – 8/11	Odakyu OX	Kyodo	Tokyo	¥598		Japan
8/5 – 8/11	Odakyu OX	Kyodo	Tokyo	¥698		Japan
8/5 – 8/11	Y's	Umegaoka	Tokyo	¥498	125 g	Oregon
8/5 – 8/11	Y's	Umegaoka	Tokyo	¥298		Japan
8/5 – 8/11	Summit	Umegaoka	Tokyo	¥358	125 g	Oregon
8/5 – 8/11	Summit	Umegaoka	Tokyo	¥398		Japan

Blueberries in Retail

Week	Store	Town	City	Price	Size	Origin
8/5 – 8/11	Peacock	Kyodo	Tokyo	¥498	125 g	
8/19 – 8/25	Life	Kanda Izumicho	Tokyo	¥298	125 g	Oregon
8/19 – 8/25	Life	Kanda Izumicho	Tokyo	¥698	311 g	Oregon
8/19 – 8/25	FUJI	Yokohama Minami	Kanagawa	¥298	125 g	Oregon

Jan 4, 2018 – Life, Kanda Izumicho Tokyo, ¥398 - 125 g (Chile)

Apr 3, 2018 – Maruetsu, Ichigaya Tokyo, ¥498 - 125 g (Mexico)

Apr 18, 2018 – Queen’s Isetan, Shinagawa Tokyo, ¥798 (Japan)

Apr 18, 2018 – National Azabu, Hiroo Tokyo, ¥1280 (Mexico)

Blueberries in Retail

Apr 20, 2018 – Odakyu OX, Umegaoka Tokyo, ¥398 - 125 g (Mexico), ¥698 (Japan)

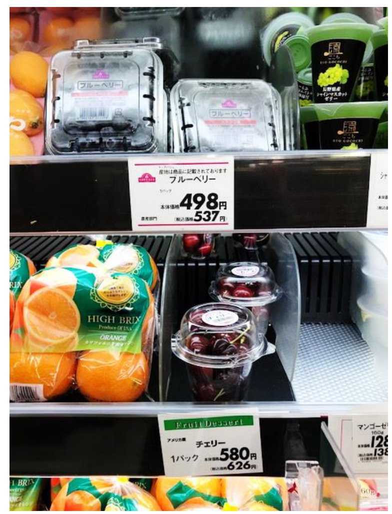
Apr 21, 2018 – Life, Kanda Izumicho Tokyo, ¥398 - 125 g (Mexico)

Apr 22, 2018 – Y's, Umegaoka Tokyo, ¥498 - 125 g (Mexico)

Apr 23, 2018 – Summit, Umegaoka Tokyo, ¥998 - 125 g (Mexico)

May 4, 2018 – Daimaru, Tokyo, ¥756 - 125 g (Mexico)

May 5, 2018 – Presse Premium, Akasaka Tokyo, ¥498 - 125 g (Mexico)

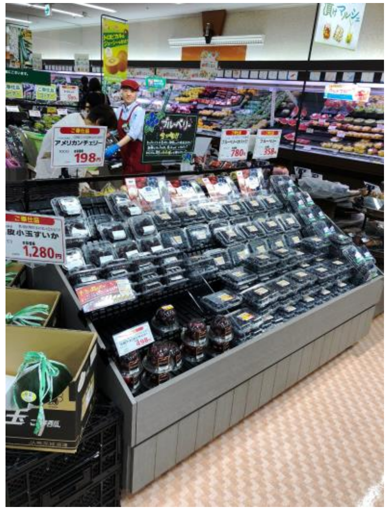


May 13, 2018 – Peacock, Kyodo Tokyo, ¥498 - 125 g (Mexico)

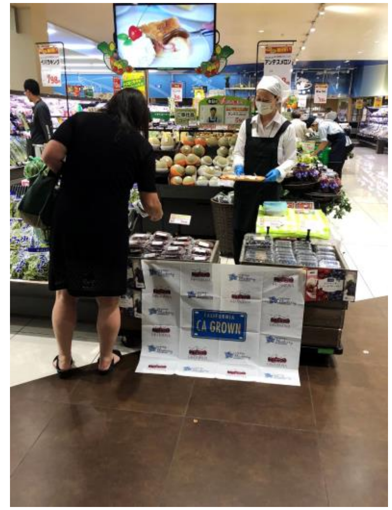
May 19, 2018 – Tsuruya, Karuizawa Nagano, ¥369 (California)

Blueberries in Retail

May 27, 2018 – Kinokuniya, Aoyama Tokyo, American Blueberry Fair

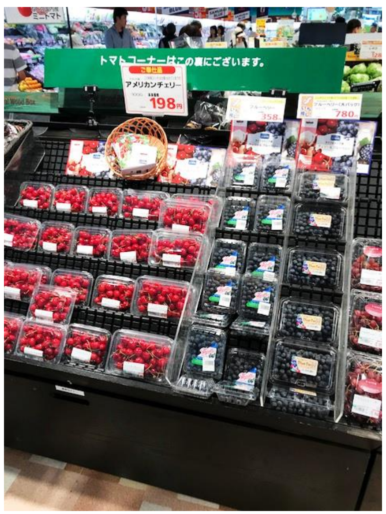


Jun 2, 2018 – Summit, Fukasawa Tokyo, ¥358/¥780 (California)



Jun 2, 2018 – Summit, Nozawa Tokyo, ¥358/¥780 (California)

Jun 3, 2018 – York Mart, Katsutadai Chiba, ¥298 (California)



Jun 3, 2018 – Summit, Kinuta Tokyo, ¥358/¥758 (California)

Jun 3, 2018 – Summit, Seijo Tokyo, ¥358/¥780 (California)

Jun 3, 2018 – Summit, Magomesawa Chiba, ¥358 – 125 g (California), ¥498 (Japan)

Jun 3, 2018 – Maruetsu, Magomesawa Chiba, ¥498 (Japan)

Blueberries in Retail

Jun 3, 2018 – Tokyu Store, Gakugei Daigaku Tokyo, ¥580 (Japan)

Jun 6, 2018 – Sakagami, Komagome Tokyo, ¥499 (California)

Jun 10, 2018 – Tokyu Store, Nozawa Tokyo, ¥498 (Mexico), ¥580 (California)

Jun 16, 2018 – Seijo Ishii, Ebisu Chiba, ¥458 (California)

Jun 16, 2018 – York Mart, Sakura Josui, Tokyo, ¥398 – 125 g (Chile)

Jun 23, 2018 – Life, Kanda Izumicho Tokyo, ¥398, ¥690 (California)

Jun 23, 2018 – Life, Kanda Izumicho Tokyo, ¥298 (Japan), ¥398/¥698 (Oregon)

Aug 21, 2018 – FUJI, Yokohama Kanagawa, ¥298 – 125 g (Oregon)

Pre-Season Meetings with Japanese Trade

Tokyo Seika Trading Co., Ltd. (Importer)

Tokyo Seika Trading Co., Ltd. began as the overseas trade division of its parent company, Tokyo Seika Co., Ltd., the largest produce wholesaler in Japan. The company was incorporated in 1981.

Tokyo Seika believes that to many Japanese, fruits are still luxurious items. They are items for special occasions like traditional gift giving, instead of something to be enjoyed every day. In their opinion, an average family in Japan purchase fruits only once or twice a week.

The main competitors of import blueberries are domestic blueberries. Good news is that blueberry consumption is increasing because it tastes good and it is very convenient. Japanese people generally think that import blueberries are expensive and do not taste as good as the Japanese counterparts. Consumers need to be communicated that California fruits taste very good, often times better than domestic fruits.

AEON Co., Ltd. (Retailer)

AEON is the largest retail group in Japan with over 300 member companies worldwide. It was started as Shinohara-ya textile shop in 1758, which was later renamed to Okada-ya (in 1887) and to JUSCO in 1969. The company adopted its AEON name in 2001. Among its retail brands are AEON, MaxValu, Daiei and Mini Stop (convenience store).

For the 2018 season, AEON had a program set up with ocean freight Mexican blueberries that ran from December 2017 through June 2018. Their initial plan for the season was to move directly from Mexico to Northwest, skipping California entirely. They used to purchase a significant amount of blueberries from California in the past, but because of high prices, they are now handling more fruits from Mexico where ocean freight option is available.

AEON wants the use of blueberries to spread to lunch and dinner where people spend the most money. They want to see more recipes that suggest use of the fruits outside of breakfast and dessert. To drive consumption, an ideal recipe would use a plenty blueberries, instead of calling for a few tens of grams. In health-conscious Japanese society, blueberries, which are full of anti-oxidants, are sure to resonate well with consumers.

Pre-Season Meetings with Japanese Trade

Japan Fraise Co., Ltd. (Importer)

Japan Fraise Co., Ltd. traces its roots to a fruit stand operating in war-torn Tokyo right after the end of the Second World War. Today, Japan Fraise imports various berries from around the world.

Japan Fraise usually brings in blueberries from Chile, California, Oregon and Washington. They prefer not to source berries from Mexico, but due to delayed supply from California this year, they had to resort to purchasing Mexican blueberries to fill the gap.

Japan Fraise was expecting to transition smoothly from Chile to California, with first shipment from California initially expected to arrive in the third week of April. Due to soft fruits and unfavorable weather, the first batch did not arrive until after the Golden Week (the first week of May). Japan Fraise buys blueberries from Chile, California, Oregon and Washington.

60% of Japan Fraise’s business goes to confectionery and the rest goes to retail and wholesale. The major retailers they deal with are Ito Yokado and York Benimaru. They also work with about 12 other small retailers.

MVM Shoji Co., Ltd. (Importer)

MVM Shoji Co., Ltd. originally started as a factory that specialize in cut-vegetables. They are known for innovative undertakings, such as cut apple vending machines that are set up in select train stations in Tokyo and Osaka. MVM Shoji began their blueberry imports with Chilean berries in 2004.

Retailers that MVM Shoji work with are Maruetsu, Seiyu and Life supermarkets. They source California blueberries from Hurst.

Pre-Season Meetings with Japanese Trade

WATARI Co., Ltd. (Importer)

WATARI began its produce business in 1972 under its previous name Watari Shokai. Today, the company has grown to a 600-employee venture with offices throughout Japan.

WATARI imports blueberries from Mexico until the end of June and switch to Oregon in early July. Some of the retailer customers they work with are San-A (in Okinawa), Sunny Mart (in Shikoku) and Yaoko (in Saitama).

Royal Co., Ltd. (Importer)

Royal was originally an import produce section of its parent company, Kyoka Kyoto Seika LLC. The company is headquartered in the ancient capital of Kyoto and has over JPY 30 Billion in annual sales.

Royal imports blueberries from Mexico and switches to California and Oregon as the season progresses. This season's supply from Oregon was expected to be good with shipments to start around June 25 – 28.

Sakagami Co., Ltd. (Retailer)

Sakagami Co., Ltd. is a small retail chain with six stores in Tokyo area. They are committed to providing the highest quality products to their customers. Sakagami usually purchases blueberries through Matsutsune, a jobber at Ota Produce Market.

Pre-Season Meetings with Japanese Trade

Wismettac Foods, Inc. (Importer)

Wismettac Foods, Inc. was established in 2015 through integration of IPM Nishimoto Co., Ltd. and a business division of Nishimoto Trading Co., Ltd. Aside from fresh produce, Wismettac handles a wide range of frozen/processed foods, sea products and other agricultural commodities. They are one of the leading importers of fresh products in Japan.

Blueberry is one of the items that Wismettac want to expand further. As a part of this endeavor, they increased their handling of Chilean blueberries in November 2017 – February 2018. In the spring, blueberries are purchased from Mexico and from California starting around the first week of May.

Currently, most of the blueberries that Wismettac handle are sold through wholesale markets, but they want to see their sales directly to retailers increase in the future.

Summit, Inc. (Retailer)

Summit was established in 1962 as joint venture between Japan's Sumitomo Shoji Co., Ltd. and Safeway. Today the company operates over 110 stores in Tokyo, Kanagawa, Chiba and Saitama.

Most of Summit's blueberries are sold in 125-gram small clamshell packages. They want to see Japanese consumers purchase bigger blueberry packs and enjoy berries daily. It may be helpful to introduce how the people in California enjoy blueberries on daily basis.

CANADA

Canada remains the largest export market for U.S. blueberries, and California has a significant impact on this statistic. Nearly 75% of total California blueberry exports are shipped to Canada. In 2018, California exports to Canada totaled 3,265,651, down from last year's 4,344,354.30. This decrease/increase can be attributed to California's decrease in production volume during the 2018 season.

In 2018, the California Blueberry Commission continued to utilize the services of Mr. Ken Berger from R.E.P.S., Inc. to serve as California's local representative in Canada. R.E.P.S., Inc. has played a crucial role in maintaining connectivity between California and Canada. Throughout the duration of the season, R.E.P.S., Inc. gathered market intelligence and distributed regular reports back to the CBC, held meetings with key major retailers in Canada, conducted weekly in-store audits during the California blueberry season, and maintained a close relationship with USDA and Canadian government representatives. R.E.P.S., Inc.'s yearly summary report from 2018 is included in the following pages.

Competition from blueberries in the U.S. from Mexico have significantly hurt California's marketing window in Canada. Additionally, competition from Oregon, Georgia, and Florida also hampered California's export program. R.E.P.S, Inc. suggested that one of the problems that he saw was that other states utilize "Grown in …" on their product. This differentiates their product from others, especially Mexico, which helps attract the Canadian buyer. Since the CBC is part of the California Grown program, the utilization of the California Grown logo on any California blueberry product is free and encouraged. It is important to note that this is not a blueberry specific problem, and other commodities such as apples, cherries, and pears are experiencing similar challenges.

Additionally, the CBC participated once again in the SIAL Conference in May 2018. The SIAL conference serves as a perfect opportunity to distribute information about California blueberries to the many buyers who attend the trade show. The SIAL conference is widely regarded as the prime conference on sustainable agriculture which the Canadian government has voiced overwhelming support. Demonstrating the sustainability of California blueberries will be of significant assistance in the very near future.

California Blueberry Commission
2018 Season Recap
Canada

From mid-April through mid-June, in-store representatives were contracted to visit all major banners, weekly, across Western Canada, Ontario, Québec and the Atlantic region, and file store audit reports with photos. These reports were then reconciled and summarized by the CBC's in-country representative in Canada who subsequently filed them with the Commission. The audits covered the following:

- Banner name
- Origin
- Pack size
- Display size (# of facings/# of packages on display)
- Display type (primary i.e. end-cap, island/secondary i.e. counter/shelf)
- Display placement within the produce department (Front/Middle/Back)
- Pricing
- Flyer ad activity
- Brand

Here are some of the more relevant weekly observations:

APRIL

- Week of Apr. 16: some Calif. blueberries began showing up primarily in Western Canada, but still saw mostly offshore and MX blues in stores across the country.
- Week of Apr. 23: a mix of origins seen everywhere across the country; southern hemisphere and MX still in good supply; Florida berries began showing up in Eastern Canada; California mostly in organics. Retailers were running plenty of ads and were clearly in transition as many ads showed multiple origins in the ad copy: *U.S. or Chile; U.S. or Mexico*, etc.
- Week of Apr. 30: Blueberry retail pricing was unseasonably high and reflected by the number of units merchandised. Retailers in Western Canada were still toggling between MX and CA, with far more MX product on shelf than CA. Retailers in QC were transitioning from MX to FL.

MAY

- Week of May 7: still observed very little in the way of blueberries from California on supermarket shelves. Even the usually loyal Western Canada region had mostly Mexican. As well, there was a sharp drop in number of banners handling organic blueberries from anywhere. Fewer flyer ads pointed to either a gap in supply or a drop in volume from exporting regions that would have occurred a couple of weeks ago – likely a thinning out of offshore berries and drop in supply out of Mexico, judging from all of the various origins cited on the labels.
- Week of May 14: Western Canada retailers were featuring U.S. blueberries in their flyers, presumably expecting the origin to be California, yet origins showed mostly Mexico at most all major retailers in the region (Save-On Foods/Overwaitea; Walmart; Loblaws Superstore; Sobeys/Safeway). In Ontario, Québec and the Atlantic region, Eastern U.S. berries were everywhere, mostly out of Georgia.

- Week of May 21: continued serious gaps in supply as 5 banners (of 24 audited) were recorded with no blueberries on shelves at all. In the west, however, Loblaws was finally showing U.S. product on its 9.8oz private label, PC Brand, *Flavour Burst* blueberries, as was Sobeys/Safeway, in both conventional and organic 6oz, and so was Costco with its 2# in conventional and 18oz in organic, all presumably from California.
- Week of May 28: Eight weeks into tracking retail activity across Canada and this week marked the first where all 6 Western Canada banners were handling a California-identified blueberry in one format or another.

JUNE

- Week of June 4: first berries from OR seen – at both Food Basics (Metro) and at Sobeys in Ontario; organic 6oz clams.
- Week of June 11 & 18: origins moving up both coasts; still plenty of California origin blueberries in Western Canada; virtually none to be seen anywhere east of the Great Lakes.

The in-store audits and flyer tracking activities yielded a lot of valuable data, recapped in the table below. The figures represent the averages for each month recorded:

	April		May		June	
	2017	2018	2017	2018	2017	2018
# of identifiable California blueberry skus recorded	n/a	7	6	4	17	10
Total # of facings		218	193	171	191	206
Total # of packages		2,950	3,191	1,978	2,488	2,300
# of flyer ads		10	11	10	9	10
# of Front Page flyer ads		3	1	2	2	2
# of skus of blueberries merchandised at Primary location within dept.		25	16	17	17	19
# of skus of blueberries merchandised at Front of dept.		27	25	25	25	29
Average mean advertised retail price:						
6oz		$2.49	$2.18	$2.74	$2.66	$2.33
Pint		$3.99	$4.99	$4.49	$4.49	$4.32
Organic 6oz		$4.24	$4.99	$4.16	$4.16	$4.33
Average mean regular retail price:						
6oz		$3.99	$4.24	$3.99	$4.33	$3.99
Pint		$6.24	$5.87	$5.24	$4.99	$4.99
Organic 6oz		$4.99	$5.62	$4.74	$5.16	$4.99

Some notes on this table:

- # of identifiable California blueberry skus recorded: down significantly this year vs. last, with the *California Grown* logo used only on a couple of brands and on organic skus mostly.
- The month of May this year appears to have seen a gap in supply from all blueberry-producing regions as seen in the decline in the Total # of facings and Total # of packages on displays versus last year.

- Blueberries, it would appear, have now moved into a coveted competitive positon in terms of pricing both on flyer feature and at regular retails, based on a marked reduction in May and June this year versus the same two months last year, and despite both higher freight rates and a weaker Canadian dollar this year. (The only reason that the 6oz sku was lower in price last year than this year is because that price includes the several banners that carried the 4.4oz sku last year.)

Recommendations for next year:

- Georgia and Florida do a much better job of marketing on their clams than California. Both the *Georgia Grown* and *Fresh from Florida* logos a very visible on a great many brands whereas there are only a couple of brands that make use of the *California Grown* logo on their clams. From a consumer awareness and trust standpoint, this can only result in a positive for the industry.
- The retail trade should be encouraged, through the allocation of funding resources, when running flyer ads, to show multiple-unit pricing: 2 for … and/or BOGOs when featuring the 170g clams. This will not only result in a larger increase in sales, it will push demand, forcing many produce managers to increase facings and display size.

U.S.-MEXICO-CANADA-AGREEMENT

The U.S.-Mexico-Canada Agreement (USMCA), is a new free trade agreement designed to replace NAFTA. It is mostly focused on aspect of trade that affects the automotive industry, however, in terms of agriculture, it focuses mostly on the trade of dairy products from the U.S. to Canada. It is shown to be in favor of the U.S., and has been estimated to provide about $70 million value to the U.S. dairy industry. With regard to other commodities, including blueberries, some additional factors that benefit all three countries include: added modern language to enhance information exchange and cooperation in relation to Ag. biotechnology trade-issues; science-based sanitary and phytosanitary (SPS) measures will be used to facilitate trade; an agreement on grading standards and services; and a commitment from the U.S., Mexico, and Canada to provide notification of any issues with SPS inspection issues within 5 days, rather than 7 days as the Trans-Pacific-Partnership called for. On November 30, 2018, during the G-20 Summit, President Trump, Canadian Prime Minister Trudeau, and Mexican President Enrique Peña Nieto officially signed the USMCA. Although it has been signed by the three leaders, this agreement must now make its way through Congress for approval. There have been a number of House and Senate Democrats, along with several Republicans, who have voiced their opposition for the deal, and it remains unclear whether it will receive the official stamp of approval in the new Congress.

Shown left to right: Mexican President Enrique Pena Nieto, U.S. President Donald Trump and Prime Minister Justin Trudeau formally signed the USMCA on November 30, 2018.

CHINA

Fresh blueberries from the U.S. do not have access to the Chinese market, but this is a high priority for the industry. The USDA has officially requested access, and China's quarantine ministry (AQSIQ) is conducting a pest risk assessment (PRA). USDA has provided details on pests of concern and how the industry addresses them. Once the PRA is completed, a market access agreement will be negotiated. China is expanding its pesticide maximum residue list, and often uses Codex MRL levels when setting domestic standards. Once China establishes a way to seek import tolerances (MRLs only without full registrations in China), numerous additional tolerances will be established. China is working on such a system.

On behalf of the CBC, Bryant Christie, Inc. (BCI) traveled to Sanya, China in 2018 to advance the blueberry market access request at the U.S.-China bilateral negotiations. One challenge for blueberries in the China negotiation is that there are two longstanding U.S. market access requests which are nearing completion: U.S. potatoes and stone fruit. Both access requests have been around since 2000 and 2003 respectively. There was good progress on both of the longstanding issues at the meeting. APHIS anticipated that both issues would be addressed in 2018, clearing the way for the blueberry market access talks to take center stage. A challenge coming out of the meeting was that unlike potatoes and stone fruit, blueberries are not linked to a Chinese market access request. This will need to be accomplished in the future to secure an agreement. This is the way China negotiates. On behalf of the CBC, BCI will attend future bilateral negotiations to remind China of the importance of this request while trying to link the issue to something that China is seeking that is deliverable and encourage a visit in 2019. CBC will also stress that after the longstanding issues, blueberries are the next market access issue to be addressed.

In previous years, China has been a huge market of opportunity for California blueberries and other U.S.-based products. However, in response to the U.S.-imposed Section 232 tariffs on steel and aluminum products, China launched its first round of retaliatory tariffs in early April. As a response, the U.S. announced Section 301 tariffs, triggering two more retaliations from China in July and August. As of April 2, 2018, the Government of China has imposed an additional 15% Safeguard Duty on some blueberry products of U.S. origin in retaliation for the U.S. imposition of Section 232 tariffs on steel and aluminum. The U.S. and China have indicated that they will hold consultations to discuss the tariff issues.

In addition to the tariffs, the trade war has created an adverse "ripple" effect on other markets. Other states who cannot feasibly ship to China anymore are now sending their products to markets that we do currently utilize, thus creating greater competition for California to maintain its current market share. This is expected to slow the process of obtaining market access for the foreseeable future.

While China is notoriously slow in granting access requests, the recent tension resulting from the tariff action may delay our progress even more for the time being.

SOUTH KOREA

Since its inception, South Korea has demonstrated remarkable economic growth and global integration. In 2004, South Korea joined the exclusive club of trillion dollar economies and has continued to steadily grow ever since. In 2011, both the U.S. and South Korea ratified the U.S.-South Korea Free Trade Agreement which was to include the systematic reduction of some of the red tape when requesting market access. Unfortunately, this doesn't seem to have happened as the U.S. blueberry market request has continually been rebuffed.

Imports are an important part of the Korean blueberry supply. Chile, the State of Oregon, and now Canada enjoy market access for fresh product to Korea. Chile supplies the largest volume of fresh blueberries, with a 79% market share in 2017. However, Chilean blueberries are counter-seasonal (September-April) and of lower quality as they are shipped via ocean freight. Fresh shipments from Chile and Oregon have grown annually and now total over 1,500 metric tons, according to official Chilean and U.S. trade statistics. Canada entered the market in 2016 and shipped 3 metric tons to Korea in 2017.

In August 2018, a bilateral discussion was held between the U.S. and South Korea. South Korea is unique because Oregon has market access, but other states do not. Talks remain focused on challenges associated with the Oregon protocol. Korea continues to focus on Sudden Oak Death (SOD), a disease that is not in the export pathway for highbush blueberries, but Korea refuses to remove onerous requirements to address this. Korea also claims there were quarantine pest detections in shipments from Oregon in 2018. With a new Korean negotiating team taking a hard line, there was little progress at the negotiations in August. Korea insisted that new access for California would require a full pest risk assessment (PRA), meaning any newly negotiated Oregon protocol(s) cannot simply be extended to California. The CBC will continue to challenge this and ask for an expedited PRA when the review is initiated. Addressing the SOD issue is needed for California as well, so that issue must be resolved before other issues.

Amending the Oregon agreement is a priority, as all future agreements will almost certainly follow that protocol. Blueberries will again be discussed in 2019, where the CBC will encourage a quick resolution to the Oregon agreement, particularly concerning Korea's unreasonable policy on SOD, so that discussion for other states can proceed.

AUSTRALIA

Domestic production is Australia's leading source of fresh blueberries. The country has a significant highbush blueberry industry, having nearly doubled its production between 2012 and 2016 from 4,600 MT to 8,700 MT. In 2016, 95% of Australia's homegrown blueberries (8,265 MT) were consumed domestically.
In 2017, Australia imported 1,241 MT of fresh blueberries/cranberries, a decrease of 39% from the previous year. Over the last decade, New Zealand has been the sources of over 99% of Australia's imported blueberries and cranberries. Under Australia's strict phytosanitary controls, New Zealand is the only supplier whose fresh blueberries are granted market access.

With regard to consumption, per capita blueberry consumption continues to grow. Increased domestic consumption is driving growth in the domestic blueberry industry. Competing breeding programs in Australia are pushing the differentiation trend toward proprietary genetics. Australian consumers, being used to domestically-produced fresh blueberries, expect a top quality product.

Australia has benefited from a surge in trade in the recent years. Australia has entered into Free Trade Agreements with the United States, China (2015), South Korea, Japan, and other regional trading partners. Although Australia is a fairly open market with minimal restrictions, blueberry access from the United States has been slow moving. Australia's Department of Agriculture and Water Resources (DAWR) continues to delay the access request by claiming a lack of resources which is preventing Australia's ability to review the request. The CBC has pressed APHIS to push back on this blatant attempt to prevent access of blueberries from the United States. APHIS has offered to assist DAWR in any way possible to expedite the access request. To APHIS' credit, they have not let the access request die and have continued to call the Australians out for their tactics.

In 2018, APHIS met with their Australian counterparts. Australia remains concerned about blueberry maggot, and while this pest does not affect the West Cost, the market access request is for U.S. blueberries, so the issue must be addressed. Australia insists on reviewing the entire country at once. Methyl Bromide fumigation studies are being completed on blueberry maggot in 2018. These will be provided to Australia to hopefully address the issue and allow the PRA to be completed. Australia is notoriously slow in advancing its PRAs, and political pressure may be needed to progress this issue prior to the 2019 negotiations. The CBC has again hired BCI to represent California blueberries in 2019 trade discussions and attend all future meetings.

NEW ZEALAND

New Zealand's domestic blueberry industry has expanded rapidly over the last few years, specializing in high quality fruit for fresh consumption. Production volume reached 3,420 MT in 2016, an 80 percent increase from 2012. According to the International Blueberry Organization (IBO), fresh blueberry imports are negligible, as New Zealand's industry produces more than enough to satisfy local domestic demand.

With regard to consumption, healthy eating is a significant trend among New Zealand consumers. The health food category (i.e., vegetarian, vegan, gluten-free, and organic products) is growing about 20 percent every year. Supermarkets are adapting to this opportunity by introducing a new layout in stores featuring one-stop "Health Food" sections, usually close to the produce.

The California blueberry industry continued to seek market access for fresh blueberries to New Zealand in 2018. This request was first made in 2014 and since that time, it has been raised at bilateral negotiations between the U.S. and New Zealand governments. New Zealand has cited staffing limitations in its delay in initiating a required pest risk assessment (PRA) needed to open the market. Once that PRA is completed, a market access agreement will be finalized and the market will open. The U.S. and New Zealand met in 2018 in the United States for plant health negotiations and APHIS again stressed the urgency of completing the PRA and opening the market.

As stated, in 2014, USDA-APHIS submitted the market access request for blueberries from the U.S. Although the New Zealanders agreed to move forward with the request without the finalized Spotted Wing Drosophila research, no new movement on the request has occurred. New Zealand's Ministry of Primary Industries (MPI) has indicated that the delay in any new market access request is due to staff shortages, but anticipated a resolution in 2018. This, however, did not occur, but the Commission will continue to encourage USDA-APHIS to increase pressure on MPI to process the request. In 2018, BCI attended the U.S.-New Zealand bilateral discussion on behalf of the CBC where officials were able to review the Oregon blueberry industry, this will hopefully address any requirement for a needed site visit to the U.S. blueberry industry.

There is an additional bilateral planned for 2019 in which the CBC will also continue these discussions.

SOUTH AFRICA

South Africa is the only commercial blueberry producer in sub-Saharan Africa. The country's domestic blueberry industry is rapidly growing from a very low base due to domestic and international investments in the sector, doubling the number of planted hectares between 2014 and 2016. Blueberry acreage has experienced steady growth over the past five years, andiIn the 2016/17 market year, about 1,300 hectares of land were devoted to planting blueberries. Based on investments from existing and new growers in the industry, projections indicate that the area devoted to blueberry planting will reach 2,000 hectares by 2020.

Fresh blueberry imports are currently minimal and range between 40 and 60 MT per year. In 2017, South Africa imported 24 MT of fresh blueberries from Zimbabwe, where there is a new and very small commercial industry. Regarding South African blueberry domestic production, it has been estimated that total volume increased 81% from 2015/2016 to 2016/2017. This increase in production has been attributed to growing demand from health-conscious consumers and the availability of blueberries in high-end supermarkets. Blueberries are perceived as an exotic and very expensive fruit by the majority of consumers in South Africa.

Fresh U.S. blueberries shipped to South Africa must be accompanied by a Phytosanitary Certificate and an Import Permit (IP). South Africa and APHIS are discussing a more formalized market access agreement for U.S. fresh blueberries, so it is not clear if South Africa will issue an import permit for access. If they do, shippers must follow the regulations included in the IP.

In December of 2017, APHIS provided the South African government information on pests of concern for exports of US blueberries to South Africa. Since then, in July 2018, South Africa identified 13 pests of concern and sought additional information on how the U.S. proposed to address the pests. This is significant because South Africa is notorious for being extremely slow to grant market access, and this is their first indication of movement in our request in quite a while.

APHIS is anticipating a response to South Africa later this year, and we hope to have additional activity to report following our response. The CBC is working with BCI on this market access request as well, and will continue to provide regular updates on any progress made in 2019.

VIETNAM

In 2018, Vietnamese government officials traveled to the U.S. in July to review the U.S. blueberry industry. They visited Washington and Michigan, however, it is important to note that the market access request is for all U.S. blueberry producing states, including California, not just the states visited. Earlier in 2018, this market access request was proceeding efficiently. Discussions in Vietnam between APHIS and their Vietnamese counterparts went well.

Initially, however, it was surprising when the Vietnamese refused to visit in the summer of 2018 unless the U.S. industry agreed to a cold treatment or irradiation, both of which were non-starters. Canceling the visit would cost the negotiations another year, so a counterproposal was needed. Although the industry was not willing to undertake cold treatment or irradiate, fumigating with methyl bromide was offered. Without such an offer, the Vietnamese would not have visited and the talks would have collapsed. This response was not ideal, as other markets do not require such steps, but methyl bromide is an established mitigation measure, and many fruits have this requirement when exporting. It will likely also be part of market access agreements with Australia and New Zealand.

Thankfully, the Vietnamese eventually relented and agreed to visit this summer. They observed a tarp MeBr fumigation in Michigan. It is important to note that if a final agreement is reached with Vietnam, and this is a requirement, the industry can work with UC Davis Professor Spenser Walse on how such fumigations work logistically. He was present in Michigan for the demonstration. (The CBC currently has ongoing research with Dr. Spencer Walse).

This example shows the challenging nature of quarantine negotiations. Reject the Vietnamese position, have the trip cancelled, lose a year of negotiations, and possibly have another commodity move to the top negotiating spot, or consider a practice which is not popular, but may allow the market to open, and then seek to remove that action later. Vietnam is more political than the Philippines, and the relationship is more difficult, but issues can move forward. It is the CBC's belief that this negotiation will be the second new market opened, behind the Philippines. The CBC and BCI will work with APHIS to advance these negotiations and seek to open the market for the 2019 season.

PHILIPPINES

In 2018, Philippine government officials traveled to the United States in July and visited Oregon and Michigan. As was the case with Vietnam, although these were the only two states visited, the market access request is still for all U.S. blueberry producing states, including California. This visit was a prerequisite for the market opening, and the CBC worked with BCI to ensure this visit occurred in 2018, thus hopefully saving a year in the negotiations. Final discussions can now occur for the 2019 crop.

The Philippines are especially concerned with industry handling practices regarding thrips. However, the Philippines are known to be nonpolitical on market access issues and we anticipate these deliberations will be sincere and based on scientific data, rather than politics. The CBC and BCI will work with APHIS to address final issues with the Philippines in order to reach a final agreement as quickly as possible.

Additionally, CBC representatives visited Manila in 2018 in an effort to make greater progress in this market access request. During their visit, they met with U.S. Embassy officials and the Philippine government to stress the importance of the 2018 site visit and the importance of the issue to the U.S. industry. It is the belief of the CBC and BCI that the Philippines will be the next market to open for California blueberries.

SOUTHEAST ASIA

The CBC, in collaboration with the California Olive Committee, participated in a trade mission that took place in Thailand (Bangkok), Malaysia (Kuala Lumpur), Singapore, and the Philippines (Manila) from July 8-13, 2018. The CBC contracted the services of Richard Lieu of Lieu Marketing Associates to organize the trade mission and facilitate meetings on behalf of the CBC. Lieu Marketing also organized a report of the trade mission, along with other valuable market information, located on the following pages.

At each of these cities—Bangkok, Kuala Lumpur, and Manila—the delegation was able to meet with the Agricultural Councilor/Attache and marketing specialists at the USDA offices of the U.S. Embassy.

A retail market tour of the major supermarkets was organized in all four cities to survey the availability of blueberries and olives. During the retail market tour, the delegation was pleased to recognize the availability of blueberries from California, together with Oregon and Washington, as well as canned California olives on the shelves of supermarkets in these four countries.

A trade meeting/luncheon was also held in each of the four cities to showcase the potential of California blueberries and California olives in these markets. The events were attended by key importers, retailers and foodservice operators. The guests were generally pleased with the products presented to them, according to the feedback received.

Malaysia Market Overview - Blueberries

Malaysia at a Glance

- Total area of 329,740 square kilometres
- A multi-ethnic, multi-religious federation of 13 states and three federal territories
- Consists of two regions (West and East Malaysia) separated by the South China Sea
- One of Southeast Asia's most vibrant economies
- Population of 31.7 million people (2016) made up of 68.6% Malays (ethnic Bumiputera), 23.4% Chinese, 7.0% Indians and others.
- Major languages spoken are Malay (official), English, Chinese dialects, Tamil
- Median age is 28 years in 2016
- Annual growth rate of the population is 1.5%
- US$1 = RM$4.06 approximately. Currency exchange can be done at airport, banks or moneychangers.

With a population of 31.7 million, it is one of the most developed nations in Southeast Asia. About half of its population falls in the middle to upper income group of consumers with GDP per capita 2016 income of $9,120. Its economy has a firm foundation that includes strong manufacturing, service and agricultural sectors.

With a Muslim population of 65 percent, the demand for halal foods by Malaysian consumers has increased over the years. The expectation of halal standard in food products have extended from meat and meat products to non-meat based products such snacks, confectionery, dairy, bakery, etc. Almost all food and ingredients destined for the food service sector must be certified halal. Halal is fast becoming recognized as a new benchmark for quality, hygiene and safety. Food products and ingredients that have halal certificates have added marketing value in Malaysia. Hence, most retailers, foodservice operators GAIN REPORT: Exporter Guide Annual 2017 Page 5 and food manufacturers are inclined to ask for halal certificates for non-meat based food products and ingredients.

The Malaysian food and beverage market is developed and sophisticated and supplied by local and imported products. With rising affluence and educational levels, consumers' shopping and eating lifestyles have changed drastically over the years. Malaysians, especially in urban and cosmopolitan areas, prefer to shop in modern retail outlets which offer one-stop shopping. However, traditional stores such as provision and grocery shops, which are conveniently located in residential areas and workplaces, are still popular.

Malaysia continues to be a net importer of food with annual imports of $13 billion. In 2016, Malaysia's total imports of consumer-oriented and edible fishery products were US$7.1 billion. Imports of this category from the United States were US$492 million, about 7 percent of market share. China is the major supplier with imports at $1.4 billion, representing 19 percent of the market share. India took the second spot with imports worth of $727 million (10%), followed by Thailand (9%), New Zealand (8%) and Australia (7%).

(Source: The World FactBook; Gain Report and Department of Statistics, Malaysia)

Blueberries in Malaysia:

- Malaysia imports blueberries and cranberries* from Peru (63% of the market share in 2016), USA (28.4%), South Africa (15.2%) and Spain (13.5%).
- US imports of blueberries and cranberries* 116 tons in 2015 to 107 tons in 2016.
- US blueberries face intense competition with other export markets such as Peru, South Africa and Argentina in Malaysia.

- However, US blueberries have gained loyal consumers due to its quality assurance and availability in most supermarkets and hypermarkets.
- Fresh temperate fruits, including blueberries, is one of the most attractive market segment for USA producers as the demand for temperate fruits has been increasing with the rising disposable incomes.
- Except for the exchange rate, there are no real barriers for products such as blueberries from USA, which are valued for their perceived high quality.

**Source: Euromonitor International. Statistics for import volumes and value of blueberries alone are not available.*

Import Tariff/Duty:

Malaysia's tariffs are typically imposed on an ad valorem basis. For certain goods, such as alcohol, wine, poultry, and pork, Malaysia charges specific duties that represent extremely high effective tariff rates. Duties for tariff lines where there is significant local production are often higher. There is a 5% duty on strawberry, raspberry and gooseberry, and 10% for other fruits except kiwi fruit which incur 30% duty. The Goods and Service Tax (GST) has been repealed and the old Sales and Service Taxation (SST) with possible modification will commence in September 2018. Malaysia is having a three months GST free holiday from June-August (2018).

Philippines Market Overview - Blueberries

Philippines at a Glance

- Total land area of 300,000 square kilometres
- Total population of 102.6 million people (2016 est.)
- 82.9% of the population are Catholics; 5% Muslim; 2.8% Evangelical; 2.3% Iglesia ni Cristo; 4.5% other Christian 4.5% and 2.5% others
- The median age is 23.4 years
- Population growth rate is 1.59%
- Filipino (based on Tagalog) and English are official languages; there are eight major dialects
- GDP Per Capita is US$2,877 (2015)
- US$1 = PHP48.33

The Philippines is one of the fastest-growing economies in Asia. Philippine Gross Domestic Product (GDP) growth reached 6.8 percent in 2016; the strongest in three years and the high-end of the Philippine Government (GPH) growth target of 6-7 percent for the year. For 2017, local economic planners expect GDP to grow 6.5-7.5 percent, increasing to 7-8 percent in the medium-term.

The bilateral relationship between the United States and the Philippines is unique because of the depth of historical and human ties, and a shared commitment to upholding democracy. Around 3.9 million Filipino-Americans1 constitute a major immigrant group in the United States, while more than 250,000 U.S. citizens reside in the Philippines. The U.S. Embassy in Manila is one of the largest overseas posts in the world reflecting the importance of this relationship.

The U.S. remains to be the Philippines' largest supplier of agricultural products, and the Philippines is its 11th largest global market. U.S. agricultural exports to the Philippines increased 11 percent to $2.5 billion in 2016, driven by a robust economy and strong consumer spending.

The Philippines continues to be the largest U.S. market in Southeast Asia for consumer-oriented F&B products with export sales of $923 million in 2016, up two percent from the previous year. Traders recorded sales of U.S. F&B products to the Philippines will surpass the $1 billion mark in 2017 as it did in 2014.

(*Source: Philippines Statistics Authority, World Fact Book, Asia Development Bank)*

Blueberries in the Philippines:

- The Philippines has witnessed increasing consumption of fresh fruits and vegetables in the last five years, and emerging trends appear to indicate improving popularity for imported fresh fruits in the country.
- However, blueberries are not officially allowed into the Philippines but some of the fruits may be available in the market. Fruit importers in the Philippines have received demands for blueberries from customers and they are keen for the regulations to be changed by the authorities.
- US blueberries are still preferred due to consistent quality but they will remain expensive. This means that Philippines will continue to seek less expensive berries from countries that may already have existing free trade ties forged as part of the ASEAN, such as Australia and New Zealand.

Import Tariffs/Duty:

Import duties of 7% are applied on US blueberries as defined in the MFN status.

Bilateral and regional free trade agreements in recent years have intensified competition from ASEAN, Australia, New Zealand and China for U.S. products. As a party to the Association of Southeast Asia Nations Free Trade Agreement (AFTA), Philippine exports to the region benefit from the lower common effective tariff applicable to products of ASEAN members. The ASEAN-Australia-New Zealand Free Trade Agreement (AANZFTA) provides products from Australia and New Zealand with the same lower tariffs as ASEAN-origin products.

Singapore Market Overview - Blueberries

Singapore at a Glance

- Total area of 697 square kilometres
- Highly developed and successful free-market economy
- One of the highest per capita GDPs (US$58,497) in the world
- Population of 5.6 million people (end of 2017) made up of 74.3% of Chinese, 13.3% Malays and 9.1% Indians
- Major languages spoken are English, Mandarin and Malay
- Median age is 39.6 years in 2017
- Low annual birth rate of less than 1%
- Tropical climate country with two distinct monsoon seasons (December-March; June-September)
- US$1 = SG$1.30 approximately. Currency exchange can be done at airport, banks or moneychangers.

Singapore is a highly developed and successful free-market economy. It enjoys a remarkably open and relatively corruption-free environment, stable prices, and a per capita GDP higher than that of most developed countries. Unemployment is very low.

Strategically located in the middle of key trade flows from Asia, Australia, Europe, the Middle East and the U.S., Singapore is highly dependent on international trade; it is the 14th largest exporter and the 15th largest importer in the world. The top five trading partners are China, Malaysia, the United States, Indonesia and Hong Kong.

Singapore is almost entirely dependent on imports for all of its food requirements as there is very little local agricultural production owing to a scarcity of land.

Being at the cross-roads of major air and sea routes within the Asia Pacific region also allows Singapore to serve as a hub and major transshipment center for much of the Southeast Asian region and the Indian subcontinent. The country's role in regional trade is demonstrated by the fact that re-exports comprise between 45-50% of total exports. It is also serves as a regional food showcase and headquarters for international food and agricultural related companies.

In 2017, the U.S. exported a record US$893 million in consumer-oriented products to Singapore, with sales expected to grow in the coming years. Singapore is the fourth largest market for U.S. agriculture, fish, and forestry products. It is a leading market for high-value consumer-oriented products. The market is dynamic with high interest in new products, yet very competitive.

(Source: The World FactBook; Gain Report and Department of Statistics, Singapore)

Blueberries in Singapore:

- In Singapore, fresh blueberries are usually imported from the US, Chile and Peru.
- Blueberries are starting to become more popular among Singaporeans due to the high level of antioxidants and the increasing trend of health-consciousness among consumers.
- As the demand for blueberries rises, wholesalers and distributors have diversified their sources of imports, importing from different countries in Latin America such as Peru and Chile, to diversifying and importing from countries in other continents, such as Morocco in Middle East and Australia in Asia Pacific.

- Prices of blueberries are influenced by the country it is imported from—blueberries imported from countries in Latin America such as Peru and Mexico are less expensive than those imported from the US.
- Additionally, with the depreciating Australian dollar versus the Singapore dollar, blueberries imported from Australia are becoming more price competitive than blueberries imported from the US.

<u>Import Duty/Tariff</u>:

There are no import tariffs or excise taxes for all food and beverages, except for alcoholic beverages and tobacco products. However, a Goods and Services Tax (GST) of 7% is levied for all goods and services at the point of distribution.

Thailand Market Overview - Blueberries

Thailand at a Glance

- Total land area of 513,120 square kilometres
- Total population of 67,976 million people, comprising 95.9% Thai. 2% Burmese and 2% of others (2016)
- 93.6% of the population are Buddhists (official religion); 4.9% are Muslims; 1.2% are Christians, and 0.3% of other religious denominations
- The median age is 36.2 years
- Thai is the official national language; English is widely spoken and understood
- GDP Per Capita is US$5,732 (2015)
- The second largest economy in the Association of Southeast Asian Nations (ASEAN)
- Thailand remains a strong agricultural competitor as it is the world's leading exporter of natural rubber, frozen shrimp, canned tuna, canned pineapples, cooked poultry, and cassava. It is also a major exporter of sugar and rice.
- US$1 = THB 35.30

Thailand is Southeast Asia's second largest economy with a Gross Domestic Product (GDP) of U.S. $449 billion. Being at the crossroads of ASEAN and other dynamic markets in Asia such as China and India, makes Thailand an investors' gateway to Asia and allows it access to a burgeoning consumer population overseas aside from its equally huge population of almost 68 million people. Having attained upper middle income status, the country aspires to reach higher-income status within the next two decades.

Thailand remains a strong agricultural competitor as it is the world's leading exporter of natural rubber, frozen shrimp, canned tuna, canned pineapples, cooked poultry, and cassava. It is also a major exporter of sugar and rice.

The economy is expected to improve in 2018 due to favorable global economic growth; increased government spending particularly on infrastructure projects; favorable private investment trends; the continual expansion of key economic sectors; reduced unemployment, and increased and household income. In addition, the continual expansion of the tourism sector will continue to fuel economic growth. Thailand is the 15th largest export market for U.S. agricultural products. In 2016, U.S. consumer oriented agri-food exports to Thailand were valued at U.S. $411 million while total U.S. agricultural imports of these products from Thailand were nearly U.S. $1.5 billion.

Thailand currently has preferential trade arrangements with the Association of Southeast Asian Nation countries (ASEAN), Australia-New Zealand, China, India, Japan, Peru, South Korea, and Chile. These agreements have created additional challenges for U.S. agricultural exports, particularly due to large tariff differentials.

(Source: The World Factbook and Asia Development Bank)

Blueberries in Thailand:

- While Thailand exports tropical fruits to many countries, particularly to China and nearby Asian ones, it imports cooler climate fresh fruits from countries such as China, New Zealand, the United States, Australia, Japan, South Korea, Chile, and South Africa.

- Imports of blueberries and cranberries* was consistent at 200 tons from 2010-2014. Import volume increased to 2015 to 250 tons, reflecting an overall compound average growth rate (CAGR) of 75.7% from 2010-2015.
- The main suppliers are USA, Australia, Canada, the UK, the Netherlands, New Zealand, Chile, China, Japan, Peru and Indonesia.
- Thailand imported 23 and 40 tons of blueberries and cranberries* from the US in 2013 and 2014, respectively. In 2015, the import volume from the US increased by a much higher rate to reach an impressive 156 tons.
- Blueberries in Thailand are considered expensive and are not so widely known, and hence are mostly purchased by higher-income consumers and expatriates.
- Despite the U.S. high potential to provide consistent high-quality produce, the United States faces a competitive disadvantage compared to competitors such as China, New Zealand, Australia, and Chile, who all have preferential access due to lower tariff rates from their free trade agreements (FTAs) with Thailand.

<u>Import Duty/Tariff</u>:

Thailand has bound its agricultural tariffs at an average of 39.9% ad valorem, compared with its average applied MFN tariff on agricultural products of 22%. MFN duties on imported processed food products range from 5% to 60%, which limits the ability of U.S. exporters of such products to compete in the Thai market. There is a 40% tariff on fresh and frozen foods, including blueberries, from the USA. Blueberries from Peru, however, have zero tariffs.

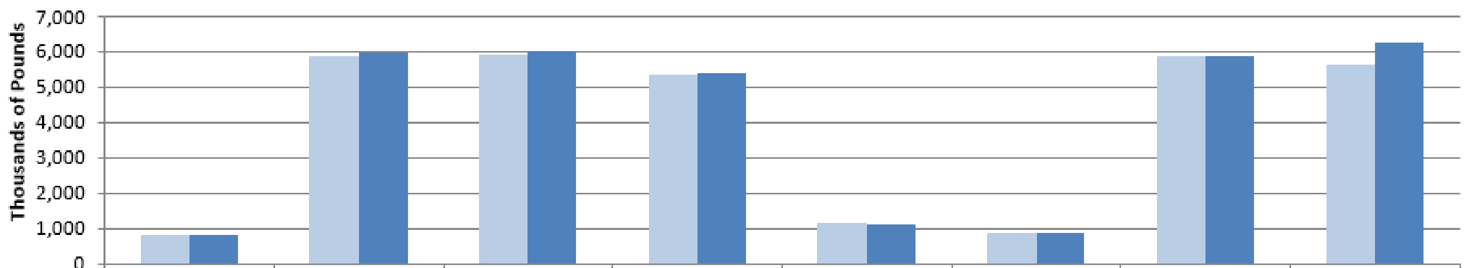
BLUEBERRY MARKETING, RESOURCE, & INFORMATION CENTER

B-MRIC SUMMARY

The Blueberry Market Resource Information Center (BMRIC) is the reporting program for the California Blueberry Commission. This program mandates that handlers report all blueberry pack styles, inventory, shipments, and price for both organic, conventional, and processed blueberries. The system is an important tool for growers, handlers, and marketers to make decisions while protecting propitiatory information.

Enclosed is a summary of the 2017 – 2018 BMRIC data. For additional information, please contact the California Blueberry Commission office.

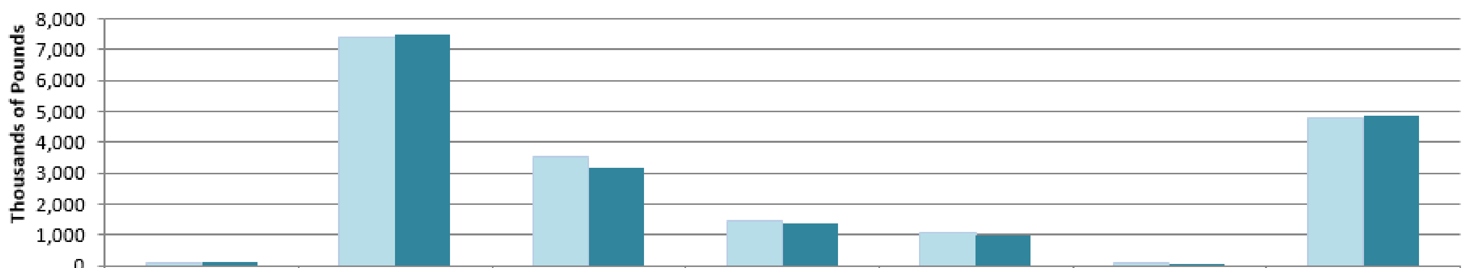
2018 Conventional Packed Inventory vs Shipped
by Package Style



	4.4 oz	6.0 oz	Pint	8x18 oz	18x18 oz	24 oz	2 lb	Other
INV	776,916	5,848,095	5,903,500	5,329,185	1,141,530	849,870	5,853,616	5,593,445
SHIP	824,967	5,974,502	6,002,364	5,409,495	1,132,369	868,158	5,852,528	6,242,233

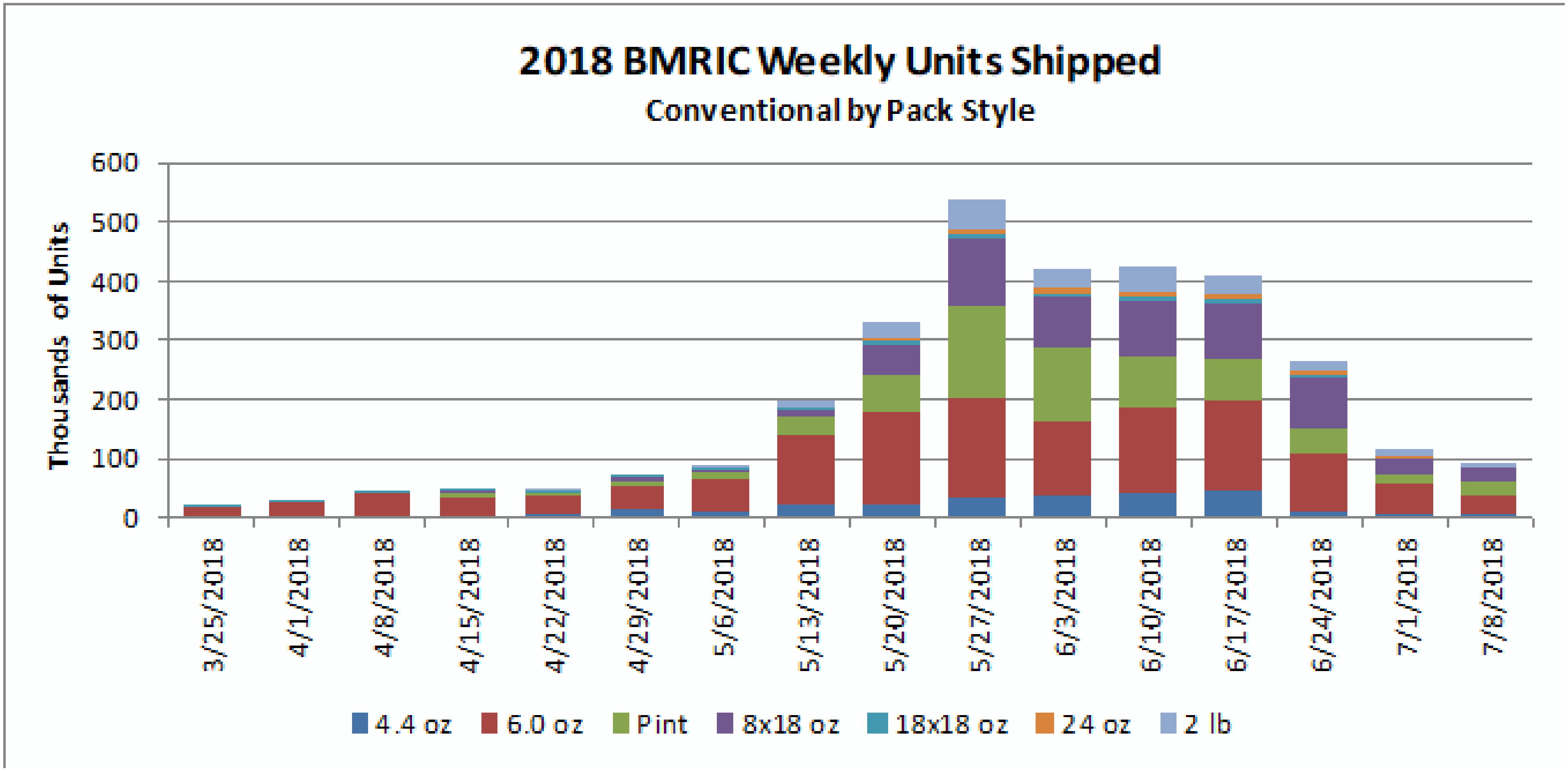
2018 BMRIC Shipment Package Style Distribution		
Conventional		
Package	Units	Pounds
4.4 oz	8%	3%
6.0 oz	42%	18%
Pint	21%	19%
8x18 oz	19%	17%
18x18 oz	2%	4%
24 oz	2%	3%
2 lb	8%	18%
Other		19%

2018 Organic Packed Inventory vs Shipped
by Package Style



	4.4 oz	6.0 oz	Pint	8x18 oz	18x18 oz	24 oz	Other
INV	103,666	7,407,953	3,535,996	1,431,837	1,065,921	88,596	4,763,502
SHIP	104,669	7,456,156	3,188,193	1,350,558	973,350	92,718	4,864,016

Organic		
Package	Units	Pounds
4.4 oz	1%	1%
6.0 oz	74%	41%
Pint	16%	18%
8x18 oz	7%	7%
18x18 oz	2%	5%
2 lb	0%	1%
Other		27%



2018 BMRIC Weekly Units Shipped
Conventional by Pack Style
Thousands of Units
600
500
400
300
200
100
0
3/25/2018
4/1/2018
4/8/2018
4/15/2018
4/22/2018
4/29/2018
5/6/2018
5/13/2018
5/20/2018
5/27/2018
6/3/2018
6/10/2018
6/17/2018
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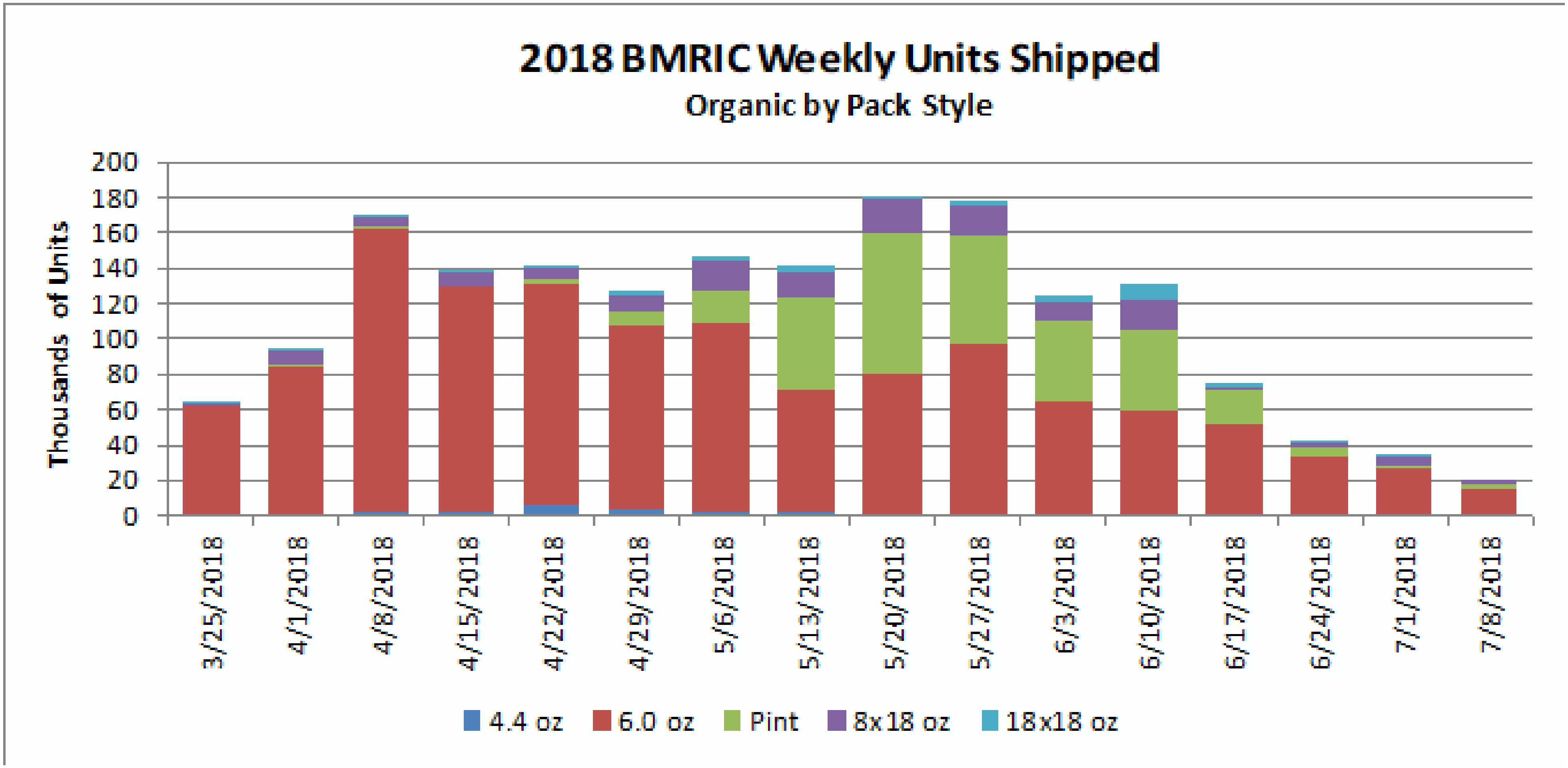
7/8/2018
4.4 oz
6.0 oz
Pint
8x18 oz
18x18 oz
24 oz
2 lb


2018 BMRIC Weekly Units Shipped
Organic by Pack Style
Thousands of Units
200
180
160
140
120
100
80
60
40
20
0
3/25/2018
4/1/2018
4/8/2018
4/15/2018
4/22/2018
4/29/2018
5/6/2018
5/13/2018
5/20/2018
5/27/2018
6/3/2018
6/10/2018
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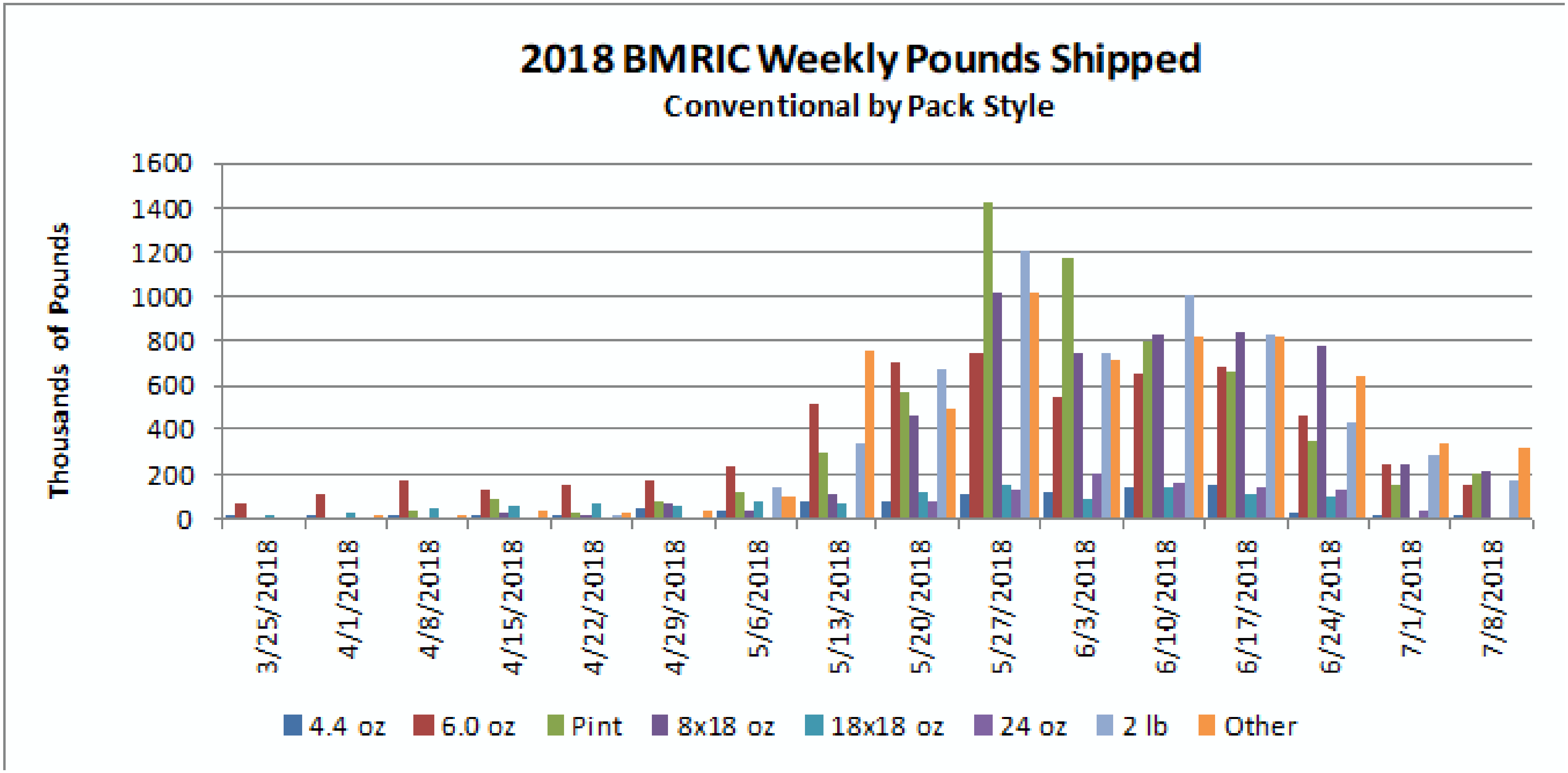
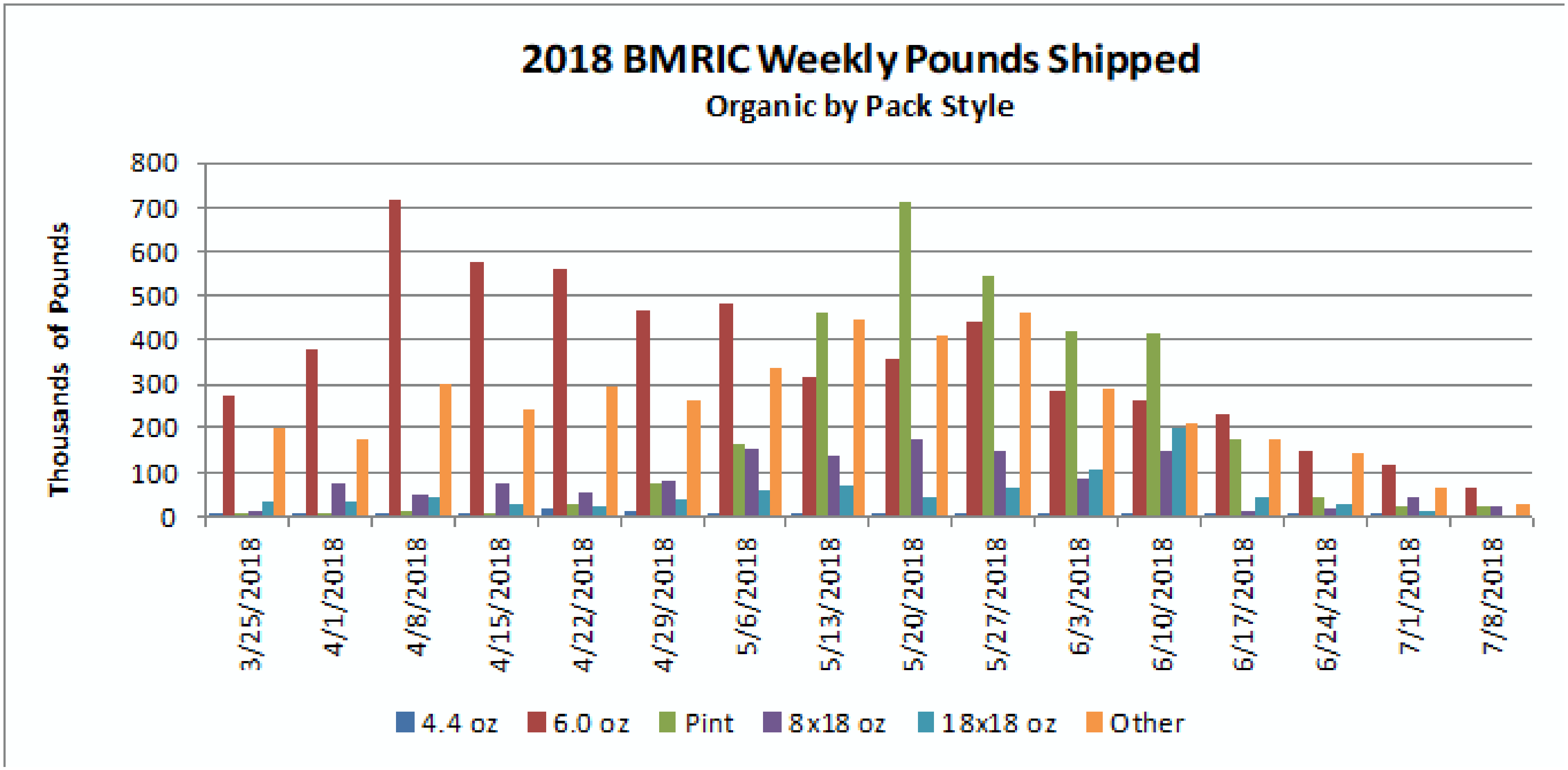
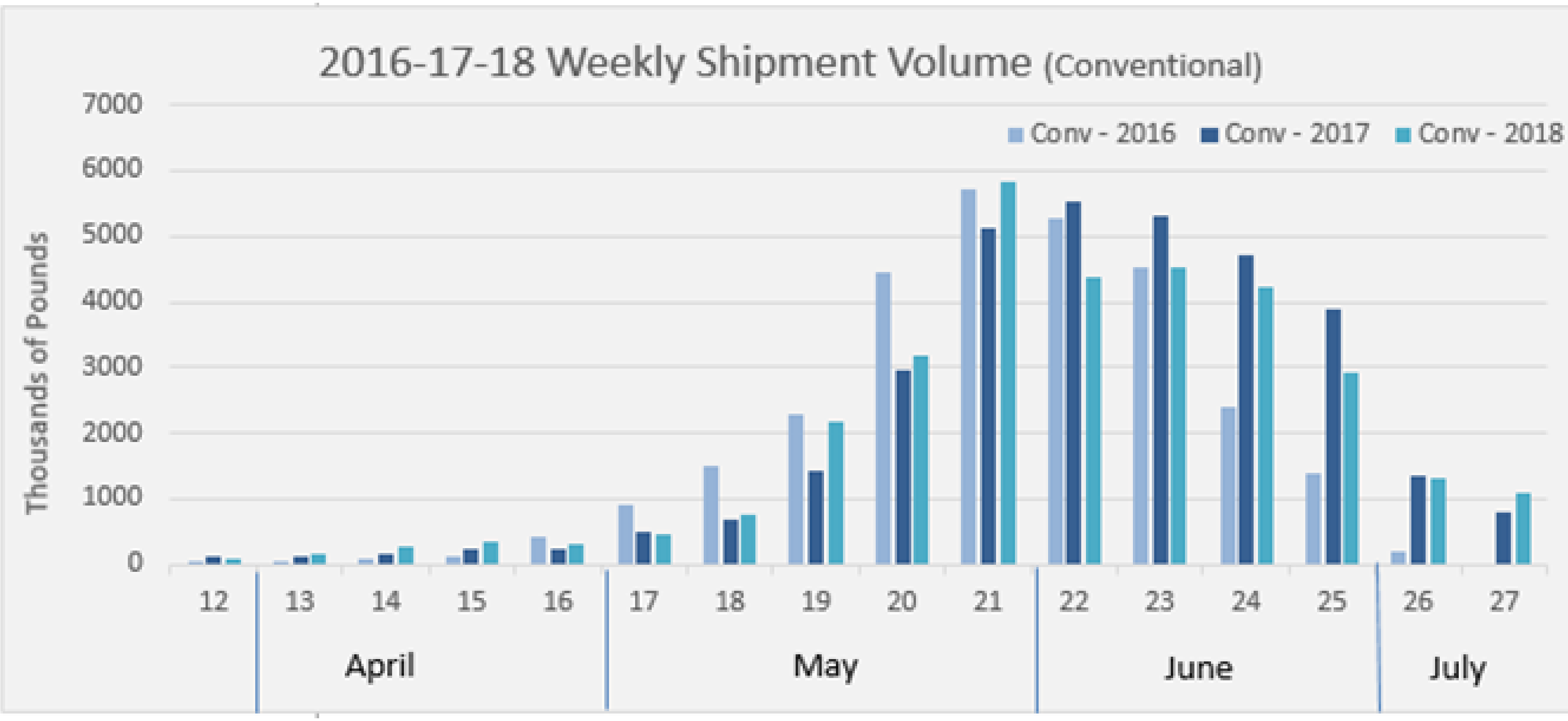
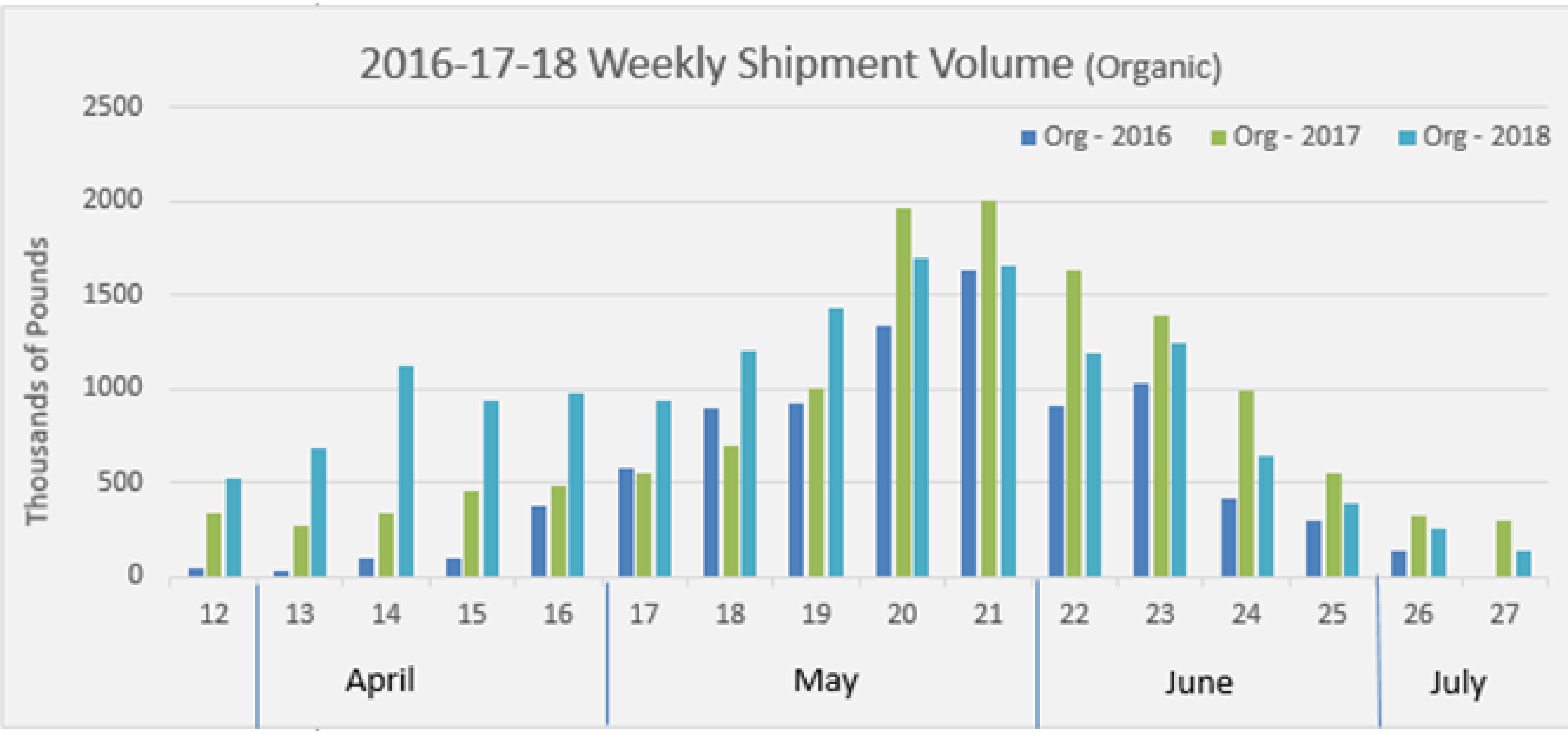
6.0 oz
Pint
8x18 oz
18x18 oz


2018 BMRIC Weekly Pounds Shipped
Conventional by Pack Style
Thousands of Pounds
1600
1400
1200
1000
800
600
400
200
0
3/25/2018
4/1/2018
4/8/2018
4/15/2018
4/22/2018
4/29/2018
5/6/2018
5/13/2018
5/20/2018
5/27/2018
6/3/2018
6/10/2018
6/17/2018
6/24/2018
7/1/2018
7/8/2018
4.4 oz
6.0 oz
Pint
8x18 oz
18x18 oz
24 oz
2 lb
Other

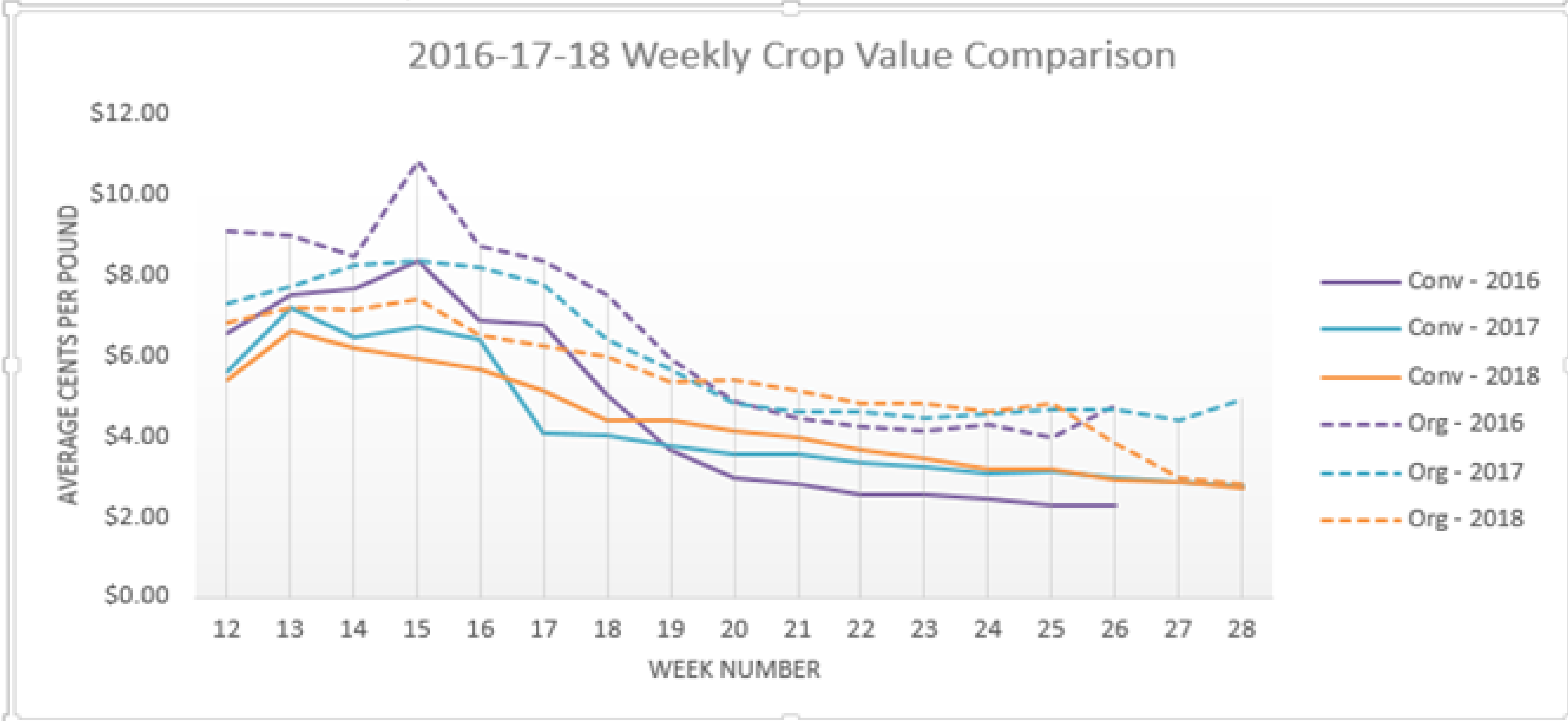


2018 BMRIC Weekly Pounds Shipped
Organic by Pack Style
Thousands of Pounds
0
100
200
300
400
500
600
700
800
3/25/2018
4/1/2018
4/8/2018
4/15/2018
4/22/2018
4/29/2018
5/6/2018
5/13/2018
5/20/2018
5/27/2018
6/3/2018
6/10/2018
6/17/2018
6/24/2018
7/1/2018
7/8/2018
4.4 oz
6.0 oz
Pint
8x18 oz
18x18 oz
Other


2016-17-18 Weekly Shipment Volume (Conventional)
Conv - 2016
Conv - 2017
Conv - 2018
Thousands of Pounds
0
1000
2000
3000
4000
5000
6000
7000
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
April
May
June
July



2016-17-18 Weekly Shipment Volume (Organic)
Org - 2016
Org - 2017
Org - 2018
Thousands of Pounds
2500
2000
1500
1000
500
0
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
April
May
June
July



2016-17-18 Weekly Crop Value Comparison
$12.00
$10.00
$8.00
$6.00
$4.00
$2.00
$0.00
AVERAGE CENTS PER POUND
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
WEEK NUMBER
Conv - 2016
Conv - 2017
Conv - 2018
Org - 2016
Org - 2017
Org - 2018

2018 BMRIC Weekly Reported Shipment Volume

TYPE: CONVENTIONAL

	Units								Pounds								
Week Ending	4.4 oz	6.0 oz	Pint	8x18 oz	18x18 oz	24 oz	2 lb	Total	4.4 oz	6.0 oz	Pint	8x18 oz	18x18 oz	24 oz	2 lb	Other	Total
1/1/18-3/18/18	742	40,430	0	0	1,020	0	0	42,192	2,449	181,935	0	0	20,655	0	0	0	205,039
3/25/2018	561	15,572			630			16,763	1,851	70,074			12,757				84,682
4/1/2018	1,602	24,633			1,275			27,510	5,286	110,849			25,818			6,358	148,311
4/8/2018	1,186	37,842	3,391		2,290			44,709	3,914	170,289	30,518		46,371			16,188	267,280
4/15/2018	2,508	29,733	9,286	2,736	2,790			47,053	8,276	133,799	83,576	24,624	56,496			29,469	336,240
4/22/2018	2,893	33,996	2,019	1,512	3,332		5	43,757	9,547	152,984	18,169	13,608	67,470		128	26,967	288,873
4/29/2018	13,867	37,827	8,887	7,146	2,467			70,194	45,760	170,222	79,983	64,314	49,956			33,843	444,078
5/6/2018	10,554	53,352	13,475	3,351	3,670		5,930	90,331	34,827	240,084	121,275	30,159	74,313		142,320	96,360	739,338
5/13/2018	21,678	114,300	33,175	11,832	3,467		14,320	198,771	71,537	514,348	298,574	106,488	70,203		343,680	764,173	2,169,003
5/20/2018	22,036	156,772	63,159	50,952	5,714	4,036	27,980	330,649	72,720	705,474	568,428	458,568	115,703	72,648	671,520	498,662	3,163,722
5/27/2018	31,817	167,596	158,606	113,521	7,713	6,975	50,185	536,412	104,996	754,182	1,427,450	1,021,689	156,181	125,550	1,204,440	1,017,854	5,812,342
6/3/2018	37,221	121,988	131,309	83,461	4,361	11,553	31,354	421,246	122,829	548,944	1,181,783	751,149	88,305	207,954	752,496	720,985	4,374,445
6/10/2018	41,269	145,307	87,804	91,736	6,698	8,828	42,003	423,645	136,188	653,880	790,239	825,624	135,628	158,904	1,008,072	811,412	4,519,946
6/17/2018	44,670	151,996	74,188	92,243	5,538	7,989	34,179	410,802	147,410	683,984	667,688	830,187	112,138	143,802	820,296	815,885	4,221,390
6/24/2018	7,256	101,923	39,329	87,106	4,957	7,080	18,055	265,705	23,944	458,652	353,961	783,954	100,375	127,440	433,320	641,589	2,923,234
7/1/2018	3,105	54,286	16,422	28,077		1,770	12,290	115,950	10,248	244,288	147,797	252,693		31,860	294,960	342,329	1,324,175
7/8/2018	5,306	32,502	22,957	24,250			7,036	92,051	17,509	146,259	206,616	218,250			168,864	322,463	1,079,960
7/15/2018	1,720	7,205	2,875	3,132			518	15,450	5,676	32,423	25,875	28,188			12,432	97,698	202,291
7/16/18-9/15/18	0	408	48	0	0	0	0	456	0	1,836	432	0	0	0	0	0	2,268
Total	249,990	1,327,667	666,929	601,055	55,919	48,231	243,855	3,193,647	824,967	5,974,502	6,002,364	5,409,495	1,132,369	868,158	5,852,528	6,242,233	32,306,615

TYPE: ORGANIC

	Units								Pounds								
Week Ending	4.4 oz	6.0 oz	Pint	8x18 oz	18x18 oz	24 oz	2 lb	Total	4.4 oz	6.0 oz	Pint	8x18 oz	18x18 oz	24 oz	2 lb	Other	Total
1/1/18-3/18/18	9,773	370,374	8,251	4,810	7,663	5,151	0	406,022	32,251	1,666,681	74,259	43,290	155,176	92,718	0	804,560	2,868,934
3/25/2018	182	61,290	578	1,008	1,610			64,668	601	275,805	5,202	9,072	32,603			201,195	524,477
4/1/2018	845	84,152	576	8,496	1,680			95,749	2,789	378,684	5,184	76,464	34,020			179,409	676,549
4/8/2018	1,867	159,571	1,300	5,328	2,100			170,166	6,161	718,068	11,700	47,952	42,525			298,925	1,125,330
4/15/2018	1,444	128,032	584	8,352	1,440			139,852	4,765	576,144	5,256	75,168	29,160			243,602	934,095
4/22/2018	5,802	125,132	3,269	5,904	1,023			141,130	19,147	563,094	29,418	53,136	20,716			295,612	981,122
4/29/2018	3,407	103,893	8,423	9,034	1,800			126,557	11,243	467,518	75,807	81,306	36,450			263,271	935,595
5/6/2018	872	107,507	18,430	17,284	3,001			147,094	2,878	483,781	165,870	155,556	60,770			338,545	1,207,399
5/13/2018	1,092	70,264	51,432	15,567	3,381			141,736	3,604	316,188	462,891	140,103	68,464			441,987	1,433,236
5/20/2018	773	79,612	79,226	19,558	2,050			181,219	2,551	358,252	713,034	176,022	41,512			405,881	1,697,252
5/27/2018	636	97,248	60,546	16,607	3,286			178,323	2,099	437,616	544,914	149,463	66,541			458,046	1,658,678
6/3/2018	587	63,329	46,396	9,590	5,250			125,152	1,937	284,983	417,564	86,310	106,312			290,438	1,187,543
6/10/2018	394	58,504	45,865	16,972	9,859			131,594	1,300	263,268	412,785	152,748	199,645			210,796	1,240,541
6/17/2018	725	50,758	19,693	1,368	2,166			74,710	2,393	228,413	177,237	12,312	43,859			178,183	642,396
6/24/2018	398	33,722	4,728	2,160	1,278			42,286	1,313	151,751	42,550	19,440	25,879			143,561	384,494
7/1/2018	208	26,216	2,433	4,608	480			33,945	686	117,971	21,897	41,472	9,720			66,930	258,676
7/8/2018		14,766	2,508	2,592				19,866		66,447	22,572	23,328				26,730	139,077
7/15/2018		6,140	2	824				6,966		27,629	17	7,416				12,150	47,212
7/16/18-9/15/18	2,713	16,415	4	0	0	0	0	19,132	8,953	73,868	36	0	0	0	0	4,198	87,054
Total	31,718	1,656,924	354,244	150,062	48,067	5,151	-	2,246,165	104,669	7,456,156	3,188,193	1,350,558	973,350	92,718	-	4,864,016	18,029,660
Grand Total	281,708	2,984,591	1,021,173	751,117	103,986	53,382	243,855	5,439,812	929,636	13,430,658	9,190,557	6,760,053	2,105,719	960,876	5,852,528	11,106,249	50,336,275

2018 BMRIC Weekly Reported Pack-Out Volume

TYPE: CONVENTIONAL

	Units								Pounds								
Week Ending	4.4 oz	6.0 oz	Pint	8x18 oz	18x18 oz	24 oz	2 lb	Total	4.4 oz	6.0 oz	Pint	8x18 oz	18x18 oz	24 oz	2 lb	Other	Total
1/1/18-3/18/18	1,207	47,016	0	0	3,378	0	0	51,601	3,983	211,572	0	0	68,405	0	0	0	283,960
3/25/2018	685	12,863			8,048			21,596	2,261	57,884			162,972			6,350	229,466
4/1/2018	583	23,552			207			24,342	1,924	105,984			4,186			14,817	126,911
4/8/2018	1,200	35,256	3,048		2,268			41,772	3,960	158,652	27,432		45,935			14,817	250,796
4/15/2018	1,673	30,337	9,963	2,640	2,721		5	47,339	5,521	136,517	89,663	23,760	55,097		128	30,005	340,691
4/22/2018	3,109	38,534	819	2,244	1,752		95	46,553	10,260	173,403	7,371	20,196	35,478		2,280	18,118	267,106
4/29/2018	11,206	41,625	5,335	6,741	1,304		217	66,428	36,980	187,313	48,014	60,669	26,407		5,208	54,954	419,544
5/6/2018	11,352	36,522	13,415	3,615	1,103		5,662	71,670	37,462	164,350	120,738	32,535	22,337		135,888	100,381	613,690
5/13/2018	21,431	115,159	24,372	17,568	3,027		15,455	197,012	70,723	518,216	219,350	158,112	61,291		370,920	598,521	1,997,133
5/20/2018	24,330	167,244	71,651	64,626	9,510	5,926	34,028	377,315	80,289	752,599	644,858	581,634	192,579	106,668	816,672	590,531	3,765,829
5/27/2018	31,704	164,535	180,862	120,962	5,950	7,359	47,588	558,960	104,623	740,409	1,627,762	1,088,658	120,487	132,462	1,142,112	848,710	5,805,222
6/3/2018	29,918	147,831	143,304	77,887	1,914	11,591	28,617	441,063	98,729	665,241	1,289,740	700,983	38,759	208,638	686,808	672,325	4,361,223
6/10/2018	51,593	153,193	89,793	87,093	6,480	6,296	47,628	442,076	170,258	689,369	808,138	783,837	131,221	113,328	1,143,072	772,702	4,611,924
6/17/2018	35,095	110,125	52,359	73,779	4,746	8,119	31,194	315,417	115,814	495,564	471,227	664,008	96,107	146,142	748,656	691,229	3,428,746
6/24/2018	6,014	92,599	26,805	84,776	3,904	6,305	16,964	237,367	19,846	416,696	241,242	762,984	79,056	113,490	407,136	479,547	2,519,996
7/1/2018	3,120	59,889	24,297	24,227	60	1,619	12,651	125,863	10,296	269,502	218,669	218,043	1,215	29,142	303,632	395,863	1,446,362
7/8/2018	1,209	17,401	8,715	20,806			3,796	51,927	3,990	78,305	78,433	187,254			91,104	168,638	607,724
7/15/2018		4,431	1,159	5,168				10,758		19,940	10,431	46,512				135,939	212,822
7/16/18-9/15/18	0	5,894	1,207	5,168	0	0	0	12,269	0	6,584	432	0	0	0	0	0	7,016
Total	235,429	1,304,008	657,103	597,300	56,372	47,215	243,901	3,141,327	776,916	5,848,095	5,903,500	5,329,185	1,141,530	849,870	5,853,616	5,593,445	31,296,157

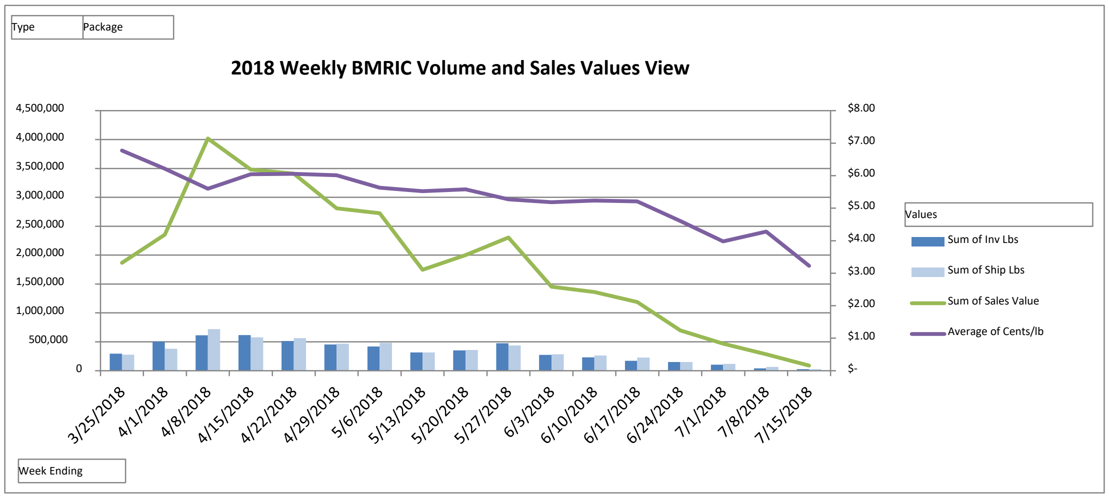
TYPE: ORGANIC

	Units								Pounds								
Week Ending	4.4 oz	6.0 oz	Pint	8x18 oz	18x18 oz	24 oz	2 lb	Total	4.4 oz	6.0 oz	Pint	8x18 oz	18x18 oz	24 oz	2 lb	Other	Total
1/1/18-3/18/18	8,165	389,393	8,381	4,861	7,374	4,922	0	423,096	26,945	1,752,269	75,429	43,749	149,324	88,596	0	844,790	2,981,100
3/25/2018	339	65,804	436	3,733	1,598			71,910	1,119	296,118	3,924	33,597	32,360			163,937	531,054
4/1/2018	1,870	112,293	806	7,058	1,416			123,443	6,171	505,319	7,254	63,522	28,674			246,869	857,808
4/8/2018	951	136,278	1,164	7,299	1,779			147,471	3,138	613,251	10,476	65,691	36,025			286,842	1,015,423
4/15/2018	1,680	137,249	7,669	8,673	1,866			157,137	5,544	617,622	69,017	78,057	37,787			320,762	1,128,788
4/22/2018	1,434	113,883	8,479	4,773	1,527			130,096	4,732	512,474	76,311	42,957	30,922			222,602	889,997
4/29/2018	3,529	100,899	9,292	10,227	2,546			126,493	11,646	454,047	83,628	92,043	51,557			266,228	959,148
5/6/2018	991	93,051	16,440	16,784	2,429			129,695	3,270	418,731	147,960	151,056	49,187			268,264	1,038,467
5/13/2018	1,785	70,430	63,172	17,611	3,450			156,448	5,891	316,935	568,551	158,499	69,863			445,596	1,565,334
5/20/2018	770	78,352	78,843	27,819	2,030			187,814	2,541	352,585	709,583	250,371	41,107			458,745	1,814,932
5/27/2018	879	105,479	97,191	12,183	2,937			218,669	2,901	474,656	874,718	109,647	59,474			458,041	1,979,436
6/3/2018	350	60,618	36,313	14,161	13,880			125,323	1,155	272,782	326,821	127,449	281,070			201,099	1,210,375
6/10/2018	795	51,788	33,513	7,553	6,079			99,728	2,624	233,046	301,617	67,977	123,101			85,493	813,857
6/17/2018	441	38,114	15,865	4,335	2,668			61,423	1,455	171,514	142,783	39,015	54,028			224,426	633,221
6/24/2018	489	33,440	1,805	6,545	495			42,774	1,614	150,482	16,245	58,905	10,024			150,519	387,788
7/1/2018		23,597	9,158	1,440	564			34,759		106,187	82,422	12,960	11,421			91,955	304,945
7/8/2018		9,474	4,356	4,038				17,868		42,633	39,204	36,342				18,225	136,404
7/15/2018		5,731	2					5,733		25,790	17					9,113	34,920
7/16/18-9/15/18	6,946	20,337	4	0	0	0	0	27,287	22,922	91,517	36	0	0	0	0	0	114,474
Total	31,414	1,646,212	392,888	159,093	52,638	4,922	-	2,287,167	103,666	7,407,953	3,535,996	1,431,837	1,065,921	88,596	-	4,763,502	18,397,471
Grand Total	266,843	2,950,219	1,049,992	756,393	109,010	52,137	243,901	5,428,495	880,582	13,256,048	9,439,496	6,761,022	2,207,451	938,466	5,853,616	10,356,947	49,693,628

TYPE: CONVENTIONAL															
	Weighted Average Price per Unit							Weighted Average Price per Pound							
Report Date	4.4 oz	6.0 oz	Pint	8x18 oz	18x18 oz	24 oz	2 lb	4.4 oz	6.0 oz	Pint	8x18 oz	18x18 oz	24 oz	2 lb	Other
3/19/2018	$24.00	$19.13						$7.27	$4.25						
3/20/2018	$22.06	$26.00			$88.75			$6.69	$5.78			$4.38			
3/21/2018	$19.25	$25.21			$88.75			$5.83	$5.60			$4.38			
3/22/2018	$17.30	$23.46						$5.24	$5.21						
3/23/2018		$24.45							$5.43						
3/24/2018	$18.00	$22.83			$88.75			$5.45	$5.07			$4.38			
3/25/2018		$34.00							$7.56						
3/26/2018		$18.64			$135.47				$4.14			$6.69			
3/27/2018	$28.00	$23.27						$8.48	$5.17						
3/28/2018	$18.00	$25.06			$135.47			$5.45	$5.57			$6.69			
3/29/2018	$20.00	$23.75			$135.47			$6.06	$5.28			$6.69			
3/30/2018	$26.64	$26.05			$158.15			$8.07	$5.79			$7.81			
3/31/2018	$27.02	$19.67						$8.19	$4.37						
4/1/2018		$26.19							$5.82						$5.71
4/2/2018	$27.28	$23.32			$158.15			$8.27	$5.18			$7.81			$6.27
4/3/2018	$27.61	$25.58			$121.40			$8.37	$5.69			$6.00			
4/4/2018	$28.88	$26.33	$46.50		$139.86			$8.75	$5.85	$5.17		$6.91			$5.71
4/5/2018	$22.56	$24.06			$121.91			$6.84	$5.35			$6.02			$5.70
4/6/2018	$26.53	$26.35			$145.60			$8.04	$5.86			$7.19			$0.05
4/7/2018	$26.00	$27.04	$53.28		$150.47			$7.88	$6.01	$5.92		$7.43			
4/8/2018		$23.02							$5.12						
4/9/2018	$26.00	$22.07	$54.27		$122.11			$7.88	$4.91	$6.03		$6.03			
4/10/2018	$22.27	$24.22		$40.00	$118.97			$6.75	$5.38		$4.44	$5.87			$5.45
4/11/2018	$20.16	$25.40	$46.62	$45.00	$117.58			$6.11	$5.64	$5.18	$5.00	$5.81			$8.02
4/12/2018	$27.74	$24.92	$54.27		$126.56			$8.41	$5.54	$6.03		$6.25			$6.73
4/13/2018	$26.00	$25.19	$44.00		$117.16			$7.88	$5.60	$4.89		$5.79			$5.71
4/14/2018	$27.79	$23.82	$54.36		$121.06			$8.42	$5.29	$6.04		$5.98			$6.23
4/15/2018		$26.23							$5.83						
4/16/2018	$28.33	$24.50	$44.89	$48.00	$113.00			$8.59	$5.44	$4.99	$5.33	$5.58			$7.93
4/17/2018	$28.30	$24.57	$44.68	$47.70	$120.78			$8.57	$5.46	$4.96	$5.30	$5.96			$6.48
4/18/2018	$21.44	$23.58		$48.25	$99.43		$165.12	$6.50	$5.24		$5.36	$4.91		$6.88	$7.40
4/19/2018	$27.94	$24.85	$47.97	$48.00	$97.81		$131.28	$8.47	$5.52	$5.33	$5.33	$4.83		$5.47	$6.77
4/20/2018	$24.15	$21.60	$38.97		$109.78			$7.32	$4.80	$4.33		$5.42			
4/21/2018	$27.21	$22.30	$45.48		$113.40			$8.25	$4.96	$5.05		$5.60			$5.39
4/22/2018		$23.63							$5.25						
4/23/2018	$22.12	$21.72		$39.27	$108.14			$6.70	$4.83		$4.36	$5.34			$6.76
4/24/2018	$24.23	$24.02	$35.46	$39.75	$94.77			$7.34	$5.34	$3.94	$4.42	$4.68			$5.39
4/25/2018	$19.05	$21.65	$36.09	$48.00	$107.28			$5.77	$4.81	$4.01	$5.33	$5.30			$6.11
4/26/2018	$19.83	$21.53	$34.93		$162.41			$6.01	$4.79	$3.88		$8.02			$5.48
4/27/2018	$21.59	$23.00	$36.00	$36.89	$94.16			$6.54	$5.11	$4.00	$4.10	$4.65			$4.47
4/28/2018	$22.24	$22.08	$43.92	$30.86	$106.72			$6.74	$4.91	$4.88	$3.43	$5.27			$5.34
4/29/2018		$21.50	$35.05						$4.78	$3.89					
4/30/2018	$20.12	$22.15	$46.26	$39.15	$107.93			$6.10	$4.92	$5.14	$4.35	$5.33			$5.96
5/1/2018	$14.16	$19.92		$30.50	$90.83			$4.29	$4.43		$3.39	$4.49			$4.90
5/2/2018	$16.62	$21.17	$33.48		$105.25		$93.25	$5.04	$4.71	$3.72		$5.20		$3.89	$6.03
5/3/2018	$17.91	$18.48	$42.71	$36.00			$92.40	$5.43	$4.11	$4.75	$4.00			$3.85	$5.50
5/4/2018	$18.73	$21.22	$39.91	$39.15	$86.27		$99.45	$5.68	$4.72	$4.43	$4.35	$4.26		$4.14	$5.41
5/5/2018	$25.12	$18.11	$36.17		$90.32		$111.84	$7.61	$4.03	$4.02		$4.46		$4.66	$4.61
5/6/2018		$21.20							$4.71						
5/7/2018	$17.26	$19.10	$32.49	$36.00	$90.52		$90.24	$5.23	$4.24	$3.61	$4.00	$4.47		$3.76	$5.01
5/8/2018	$17.68	$20.11	$38.54	$38.43	$93.56		$91.58	$5.36	$4.47	$4.28	$4.27	$4.62		$3.82	$4.97
5/9/2018	$17.01	$20.22	$32.43	$34.14	$88.49		$90.24	$5.15	$4.49	$3.60	$3.79	$4.37		$3.76	$5.10
5/10/2018	$17.77	$19.05	$33.51	$29.40	$90.52		$91.66	$5.39	$4.23	$3.72	$3.27	$4.47		$3.82	$5.40
5/11/2018	$19.25	$18.96	$34.25	$45.38	$87.28		$90.00	$5.83	$4.21	$3.81	$5.04	$4.31		$3.75	$4.81
5/12/2018	$18.11	$18.69	$33.87	$38.20	$87.89		$91.14	$5.49	$4.15	$3.76	$4.24	$4.34		$3.80	$4.45
5/13/2018		$20.00	$31.96	$26.00	$86.27				$4.45	$3.55	$2.89	$4.26			$6.41
5/14/2018	$16.30	$18.77	$30.26	$35.80	$91.73		$92.28	$4.94	$4.17	$3.36	$3.98	$4.53		$3.85	$4.56
5/15/2018	$17.27	$20.18	$34.14	$31.74	$93.56		$87.41	$5.23	$4.48	$3.79	$3.53	$4.62		$3.64	$4.83
5/16/2018	$16.53	$20.10	$29.48	$33.50	$89.10	$63.83	$89.14	$5.01	$4.47	$3.28	$3.72	$4.40	$3.55	$3.71	$4.52
5/17/2018	$17.01	$20.82	$34.54	$29.19	$93.56	$63.48	$87.90	$5.15	$4.63	$3.84	$3.24	$4.62	$3.53	$3.66	$5.89
5/18/2018	$13.35	$20.39	$31.75	$33.35	$88.70	$63.66	$89.58	$4.04	$4.53	$3.53	$3.71	$4.38	$3.54	$3.73	$3.89
5/19/2018	$16.77	$20.50	$34.54	$32.92	$89.71	$63.68	$89.42	$5.08	$4.56	$3.84	$3.66	$4.43	$3.54	$3.73	$5.22
5/20/2018		$19.87	$28.27	$36.00	$88.70	$63.81	$89.52		$4.42	$3.14	$4.00	$4.38	$3.55	$3.73	$5.13
5/21/2018	$17.83	$20.44	$29.15	$34.29	$90.32	$63.95	$88.94	$5.40	$4.54	$3.24	$3.81	$4.46	$3.55	$3.71	$4.27
5/22/2018	$14.30	$20.46	$34.30	$36.70	$93.56	$63.77	$88.27	$4.33	$4.55	$3.81	$4.08	$4.62	$3.54	$3.68	$5.90
5/23/2018	$15.73	$21.05	$33.33	$29.51	$90.32	$68.76	$87.84	$4.77	$4.68	$3.70	$3.28	$4.46	$3.82	$3.66	$4.36
5/24/2018	$17.72	$19.91	$34.11	$35.03	$91.33	$57.28	$88.78	$5.37	$4.42	$3.79	$3.89	$4.51	$3.18	$3.70	$4.61
5/25/2018	$15.63	$20.43	$32.87	$33.43	$88.90	$58.70	$91.36	$4.74	$4.54	$3.65	$3.71	$4.39	$3.26	$3.81	$3.70
5/26/2018	$13.62	$19.89	$34.12	$34.45	$89.35		$90.21	$4.13	$4.42	$3.79	$3.83	$4.41		$3.76	$3.79
5/27/2018	$20.00	$20.44	$32.54	$31.89			$87.41	$6.06	$4.54	$3.62	$3.54			$3.64	$3.53
5/28/2018	$16.30	$19.52	$33.72	$31.18	$71.89		$88.20	$4.94	$4.34	$3.75	$3.46	$3.55		$3.68	$4.04
5/29/2018	$13.32	$18.63	$28.74	$31.52	$66.83	$60.11	$88.58	$4.04	$4.14	$3.19	$3.50	$3.30	$3.34	$3.69	$4.25
5/30/2018	$13.61	$19.03	$31.06	$28.92	$72.50	$61.34	$89.65	$4.12	$4.23	$3.45	$3.21	$3.58	$3.41	$3.74	$3.65
5/31/2018	$14.69	$18.69	$29.31	$29.17	$72.50	$65.22	$87.06	$4.45	$4.15	$3.26	$3.24	$3.58	$3.62	$3.63	$3.87
6/1/2018	$13.51	$18.59	$27.41	$28.74		$60.14	$89.78	$4.09	$4.13	$3.05	$3.19		$3.34	$3.74	$4.80
6/2/2018	$14.30	$18.28	$29.87	$28.42	$67.64	$68.49	$82.99	$4.33	$4.06	$3.32	$3.16	$3.34	$3.80	$3.46	$3.63
6/3/2018		$18.86	$33.14	$32.88					$4.19	$3.68	$3.65				$3.78
6/4/2018	$14.07	$17.26	$29.03	$29.89	$67.43	$67.06	$80.76	$4.26	$3.83	$3.23	$3.32	$3.33	$3.73	$3.36	$3.49
6/5/2018	$13.33	$18.04	$28.55	$30.30	$67.41	$64.88	$81.63	$4.04	$4.01	$3.17	$3.37	$3.33	$3.60	$3.40	$3.36

6/6/2018	$18.87	$17.93	$28.96	$32.69	$67.23	$63.87	$80.39	$5.72	$3.98	$3.22	$3.63	$3.32	$3.55	$3.35	$3.07
6/7/2018	$13.03	$17.53	$29.68	$30.25	$68.45	$56.28	$80.62	$3.95	$3.90	$3.30	$3.36	$3.38	$3.13	$3.36	$3.95
6/8/2018	$12.74	$17.03	$25.46	$23.96	$66.42	$62.43	$83.00	$3.86	$3.78	$2.83	$2.66	$3.28	$3.47	$3.46	$3.04
6/9/2018	$13.74	$16.67	$28.62	$27.12	$66.02		$81.48	$4.16	$3.70	$3.18	$3.01	$3.26		$3.39	$3.60
6/10/2018		$19.07	$28.17	$30.38	$66.02		$81.12		$4.24	$3.13	$3.38	$3.26		$3.38	$3.44
6/11/2018	$13.48	$16.25	$27.15	$26.19	$66.22	$61.30	$81.62	$4.08	$3.61	$3.02	$2.91	$3.27	$3.41	$3.40	$2.64
6/12/2018	$12.64	$14.53	$25.26	$26.73	$66.42	$62.27	$81.17	$3.83	$3.23	$2.81	$2.97	$3.28	$3.46	$3.38	$3.10
6/13/2018	$13.14	$14.96	$18.22	$27.79	$66.02	$58.80	$80.88	$3.98	$3.33	$2.02	$3.09	$3.26	$3.27	$3.37	$2.69
6/14/2018	$14.62	$15.46	$26.54	$31.68	$66.83	$51.57	$81.08	$4.43	$3.44	$2.95	$3.52	$3.30	$2.86	$3.38	$2.99
6/15/2018	$13.38	$13.35	$23.18	$25.27	$67.03	$52.92	$78.12	$4.05	$2.97	$2.58	$2.81	$3.31	$2.94	$3.25	$2.91
6/16/2018	$17.20	$15.44	$25.15	$26.07	$67.64	$48.33	$72.77	$5.21	$3.43	$2.79	$2.90	$3.34	$2.68	$3.03	$3.34
6/17/2018		$18.75	$30.49	$24.45	$67.84				$4.17	$3.39	$2.72	$3.35			$4.30
6/18/2018	$15.14	$16.38	$21.52	$26.44	$66.83	$49.93	$76.81	$4.59	$3.64	$2.39	$2.94	$3.30	$2.77	$3.20	$2.91
6/19/2018	$16.22	$16.29	$25.80	$26.50	$64.60	$55.17	$69.31	$4.91	$3.62	$2.87	$2.94	$3.19	$3.07	$2.89	$2.69
6/20/2018	$21.21	$14.73	$25.06	$26.04	$58.52	$47.57	$67.92	$6.43	$3.27	$2.78	$2.89	$2.89	$2.64	$2.83	$3.30
6/21/2018	$14.92	$15.96	$24.80	$24.06	$55.28	$45.33	$70.34	$4.52	$3.55	$2.76	$2.67	$2.73	$2.52	$2.93	$3.05
6/22/2018	$15.74	$16.15	$22.55	$24.99	$57.31	$49.87	$68.13	$4.77	$3.59	$2.51	$2.78	$2.83	$2.77	$2.84	$2.70
6/23/2018	$32.12	$15.80	$23.72	$25.58	$52.25		$66.90	$9.73	$3.51	$2.64	$2.84	$2.58		$2.79	$2.52
6/24/2018		$19.04		$26.17	$52.25		$68.88		$4.23		$2.91	$2.58		$2.87	$3.45
6/25/2018	$17.56	$15.82	$24.11	$23.12	$52.25		$35.02	$5.32	$3.52	$2.68	$2.57	$2.58		$1.46	$2.20
6/26/2018	$12.85	$13.18	$22.36	$20.68		$52.77	$64.80	$3.89	$2.93	$2.48	$2.30		$2.93	$2.70	$3.32
6/27/2018	$13.67	$15.98	$23.90	$20.46			$65.05	$4.14	$3.55	$2.66	$2.27			$2.71	$2.85
6/28/2018	$12.47	$15.58	$22.60	$22.34		$45.72	$63.60	$3.78	$3.46	$2.51	$2.48		$2.54	$2.65	$2.59
6/29/2018	$12.47	$14.42	$24.25	$20.58			$64.56	$3.78	$3.20	$2.69	$2.29			$2.69	$2.67
6/30/2018		$15.72	$23.94	$22.68			$64.08		$3.49	$2.66	$2.52			$2.67	$2.87
7/1/2018		$12.91	$25.00	$24.00					$2.87	$2.78	$2.67				$2.35
7/2/2018	$12.60	$15.18	$20.70	$19.20		$47.76		$3.82	$3.37	$2.30	$2.13		$2.65		$3.04
7/3/2018	$11.35	$13.93	$13.15	$21.93				$3.44	$3.09	$1.46	$2.44				$2.92
7/4/2018	$13.53	$17.77	$25.81	$26.67			$73.62	$4.10	$3.95	$2.87	$2.96			$3.07	$2.80
7/5/2018	$12.47	$14.75	$18.90	$17.76			$55.92	$3.78	$3.28	$2.10	$1.97			$2.33	$2.77
7/6/2018	$13.85	$13.83	$20.24	$19.59			$64.77	$4.20	$3.07	$2.25	$2.18			$2.70	$2.20
7/7/2018	$22.00	$14.98	$19.76	$19.19			$56.88	$6.67	$3.33	$2.20	$2.13			$2.37	$2.67
7/8/2018		$13.75	$20.70						$3.06	$2.30					$2.82
7/9/2018	$12.59	$13.94	$20.03	$17.55			$63.36	$3.81	$3.10	$2.23	$1.95			$2.64	$2.81
7/10/2018	$13.23	$14.88	$17.94	$16.86			$47.04	$4.01	$3.31	$1.99	$1.87			$1.96	$2.72
7/11/2018	$14.65	$15.80	$19.48	$20.92				$4.44	$3.51	$2.16	$2.32				$2.79
7/12/2018	$12.47	$13.85	$19.05	$19.71				$3.78	$3.08	$2.12	$2.19				$2.75
7/13/2018		$13.75		$22.25					$3.06		$2.47				
TYPE: Organic															
	Weighted Average Price per Unit							**Weighted Average Price per Pound**							
Report Date	**4.4 oz**	**6.0 oz**	**Pint**	**8x18 oz**	**18x18 oz**	**24 oz**	**2 lb**	**4.4 oz**	**6.0 oz**	**Pint**	**8x18 oz**	**18x18 oz**	**24 oz**	**2 lb**	**Other**
3/19/2018		$29.36	$55.00	$47.18	$127.25				$6.52	$6.11	$5.24	$6.28			$5.64
3/20/2018	$32.00	$29.56		$46.85	$104.46			$9.70	$6.57		$5.21	$5.16			$6.62
3/21/2018		$32.06	$55.00						$7.13	$6.11					$3.24
3/22/2018	$32.00	$30.92	$28.00		$128.92			$9.70	$6.87	$3.11		$6.37			$6.62
3/23/2018	$32.78	$30.54	$55.00					$9.93	$6.79	$6.11					$6.50
3/24/2018		$29.62			$104.56				$6.58			$5.16			$6.78
3/25/2018		$33.20							$7.38						$6.87
3/26/2018		$31.23	$55.00		$151.11				$6.94	$6.11		$7.46			$6.56
3/27/2018	$34.00	$30.58		$53.95	$134.56			$10.30	$6.79		$5.99	$6.64			$7.28
3/28/2018	$34.60	$28.90	$55.00	$55.20	$155.00			$10.48	$6.42	$6.11	$6.13	$7.65			$7.11
3/29/2018	$34.27	$30.63		$55.25	$134.56			$10.38	$6.81		$6.14	$6.64			$6.86
3/30/2018	$34.38	$27.23	$55.00	$56.95				$10.42	$6.05	$6.11	$6.33				$5.33
3/31/2018	$35.12	$27.30						$10.64	$6.07						$6.79
4/1/2018	$36.00	$24.22						$10.91	$5.38						$6.63
4/2/2018	$33.84	$27.10			$150.87			$10.26	$6.02			$7.45			$7.12
4/3/2018	$35.46	$27.27	$63.51		$134.63			$10.74	$6.06	$7.06		$6.65			$6.85
4/4/2018	$34.00	$25.41	$30.00	$56.95	$152.89			$10.30	$5.65	$3.33	$6.33	$7.55			$6.67
4/5/2018	$35.54	$23.51	$58.00	$56.95	$66.96			$10.77	$5.22	$6.44	$6.33	$3.31			$7.31
4/6/2018	$34.00	$23.20		$58.01				$10.30	$5.16		$6.45				$6.94
4/7/2018	$33.29	$26.13	$64.00		$153.16			$10.09	$5.81	$7.11		$7.56			$6.62
4/8/2018	$34.00	$26.61						$10.30	$5.91						$6.71
4/9/2018	$34.00	$29.99	$59.50		$145.74			$10.30	$6.66	$6.61		$7.20			$6.12
4/10/2018	$35.50	$28.27		$63.95	$134.75			$10.76	$6.28		$7.11	$6.65			$6.71
4/11/2018	$29.14	$25.51	$55.00		$155.53			$8.83	$5.67	$6.11		$7.68			$7.18
4/12/2018	$34.00	$28.97	$40.00		$152.08			$10.30	$6.44	$4.44		$7.51			$7.24
4/13/2018	$34.00	$24.81	$61.00	$62.13	$143.92			$10.30	$5.51	$6.78	$6.90	$7.11			$6.69
4/14/2018	$32.32	$27.74			$155.45			$9.79	$6.16			$7.68			$7.38
4/15/2018	$32.16	$29.46						$9.75	$6.55						$6.99
4/16/2018	$31.00	$29.85		$62.61	$144.39			$9.39	$6.63		$6.96	$7.13			$6.66
4/17/2018	$33.00	$28.06	$47.56		$138.00			$10.00	$6.24	$5.28		$6.81			$5.43
4/18/2018		$25.33	$65.43		$133.67				$5.63	$7.27		$6.60			$6.46
4/19/2018	$32.91	$28.16	$51.29	$54.00	$134.81			$9.97	$6.26	$5.70	$6.00	$6.66			$6.54
4/20/2018	$26.60	$28.80	$41.60	$63.82				$8.06	$6.40	$4.62	$7.09				$6.15
4/21/2018	$30.66	$27.40						$9.29	$6.09						$6.52
4/22/2018	$32.00	$30.10						$9.70	$6.69						$6.60
4/23/2018		$26.36	$39.27	$38.52					$5.86	$4.36	$4.28				$6.43
4/24/2018	$31.69	$27.48	$42.00	$55.33				$9.60	$6.11	$4.67	$6.15				$5.73
4/25/2018	$32.74	$27.25	$37.62	$38.52				$9.92	$6.06	$4.18	$4.28				$3.29
4/26/2018	$31.65	$25.67		$38.52	$124.92			$9.59	$5.70		$4.28	$6.17			$6.24
4/27/2018	$33.00	$28.63	$40.18	$52.30	$120.08			$10.00	$6.36	$4.46	$5.81	$5.93			$6.39
4/28/2018		$27.85	$37.62	$38.25	$123.70				$6.19	$4.18	$4.25	$6.11			$6.16

4/29/2018		$30.74							$6.83						$6.55
4/30/2018	$31.00	$25.66	$35.01	$37.26	$111.75			$9.39	$5.70	$3.89	$4.14	$5.52			$5.75
5/1/2018	$33.73	$26.19	$39.56	$51.93	$121.62			$10.22	$5.82	$4.40	$5.77	$6.01			$5.36
5/2/2018		$26.31	$38.45	$34.47	$111.02				$5.85	$4.27	$3.83	$5.48			$5.80
5/3/2018	$25.00	$26.68	$38.05	$36.81	$111.75			$7.58	$5.93	$4.23	$4.09	$5.52			$6.29
5/4/2018	$34.00	$24.79	$36.33	$48.50	$110.58			$10.30	$5.51	$4.04	$5.39	$5.46			$5.69
5/5/2018	$31.10	$24.09		$31.50	$120.52			$9.43	$5.35		$3.50	$5.95			$5.27
5/6/2018	$32.00	$30.53	$37.88					$9.70	$6.78	$4.21					$6.10
5/7/2018	$35.00	$26.23	$37.13	$34.20	$109.83			$10.61	$5.83	$4.13	$3.80	$5.42			$6.07
5/8/2018	$26.01	$23.99	$35.47	$29.07	$101.43			$7.88	$5.33	$3.94	$3.23	$5.01			$5.62
5/9/2018	$31.06	$24.96	$30.62	$41.99	$94.78			$9.41	$5.55	$3.40	$4.67	$4.68			$5.42
5/10/2018	$26.32	$24.06	$31.17	$37.28	$101.75			$7.98	$5.35	$3.46	$4.14	$5.02			$5.42
5/11/2018		$25.33	$31.28	$46.83	$97.40				$5.63	$3.48	$5.20	$4.81			$4.39
5/12/2018	$34.00	$24.49	$31.08	$35.01	$112.54			$10.30	$5.44	$3.45	$3.89	$5.56			$5.40
5/13/2018		$27.82		$48.50	$88.90				$6.18		$5.39	$4.39			$5.61
5/14/2018	$23.00	$26.90	$31.18	$43.42	$108.11			$6.97	$5.98	$3.46	$4.82	$5.34			$5.52
5/15/2018	$31.96	$26.46	$31.11	$39.47	$107.93			$9.68	$5.88	$3.46	$4.39	$5.33			$5.58
5/16/2018	$32.00	$24.36	$31.05	$47.43	$108.73			$9.70	$5.41	$3.45	$5.27	$5.37			$4.77
5/17/2018	$27.94	$24.59	$32.09	$47.30				$8.47	$5.46	$3.57	$5.26				$5.26
5/18/2018	$26.13	$25.45	$32.29	$43.96	$106.52			$7.92	$5.66	$3.59	$4.88	$5.26			$4.28
5/19/2018	$29.46	$25.58	$30.73	$24.96	$109.59			$8.93	$5.68	$3.41	$2.77	$5.41			$5.10
5/20/2018	$23.00	$23.43	$35.23	$48.75				$6.97	$5.21	$3.91	$5.42				$5.55
5/21/2018	$23.00	$25.38	$31.51	$39.42	$107.73			$6.97	$5.64	$3.50	$4.38	$5.32			$5.33
5/22/2018		$25.05	$33.69	$46.72	$101.48				$5.57	$3.74	$5.19	$5.01			$5.55
5/23/2018	$29.00	$22.86	$32.47	$33.59	$105.02			$8.79	$5.08	$3.61	$3.73	$5.19			$5.19
5/24/2018	$34.00	$23.00	$33.45	$38.43	$101.71			$10.30	$5.11	$3.72	$4.27	$5.02			$4.79
5/25/2018	$22.77	$24.11	$33.06	$41.15	$107.73			$6.90	$5.36	$3.67	$4.57	$5.32			$3.50
5/26/2018	$30.63	$23.15	$35.58	$39.15	$106.92			$9.28	$5.14	$3.95	$4.35	$5.28			$4.74
5/27/2018		$27.07	$34.00	$42.48					$6.02	$3.78	$4.72				$5.56
5/28/2018	$21.96	$24.38	$37.58	$26.47				$6.66	$5.42	$4.18	$2.94				$4.97
5/29/2018	$30.00	$22.86	$30.92	$49.46	$99.63			$9.09	$5.08	$3.44	$5.50	$4.92			$3.93
5/30/2018	$27.31	$24.27	$33.67	$38.13	$99.83			$8.28	$5.39	$3.74	$4.24	$4.93			$4.79
5/31/2018	$20.50	$23.09	$34.40	$24.00	$85.00			$6.21	$5.13	$3.82	$2.67	$4.20			$4.93
6/1/2018	$30.00	$22.75	$29.54	$37.93	$93.36			$9.09	$5.05	$3.28	$4.21	$4.61			$4.81
6/2/2018	$30.00	$23.46	$31.38	$35.19	$92.61			$9.09	$5.21	$3.49	$3.91	$4.57			$4.81
6/3/2018	$21.00	$24.29	$32.32					$6.36	$5.40	$3.59					$5.22
6/4/2018	$20.00	$22.06	$32.17	$31.52	$93.25			$6.06	$4.90	$3.57	$3.50	$4.60			$4.11
6/5/2018		$23.48	$30.82	$35.10	$97.82				$5.22	$3.42	$3.90	$4.83			$4.76
6/6/2018	$24.00	$22.29	$28.42	$31.79	$97.01			$7.27	$4.95	$3.16	$3.53	$4.79			$4.88
6/7/2018	$21.00	$23.25	$29.20	$42.94	$94.87			$6.36	$5.17	$3.24	$4.77	$4.68			$4.11
6/8/2018	$30.00	$24.44	$31.80	$33.39	$97.78			$9.09	$5.43	$3.53	$3.71	$4.83			$4.32
6/9/2018	$28.00	$23.42	$32.10	$36.45	$96.56			$8.48	$5.20	$3.57	$4.05	$4.77			$5.09
6/10/2018		$24.55			$105.71				$5.46			$5.22			$5.19
6/11/2018	$21.00	$25.75	$28.97	$44.48	$100.91			$6.36	$5.72	$3.22	$4.94	$4.98			$4.67
6/12/2018	$30.75	$23.33	$20.49	$38.52	$96.12			$9.32	$5.18	$2.28	$4.28	$4.75			$4.76
6/13/2018		$25.03	$32.77	$34.29	$101.66				$5.56	$3.64	$3.81	$5.02			$5.04
6/14/2018	$21.00	$23.23	$27.88		$99.83			$6.36	$5.16	$3.10		$4.93			$4.92
6/15/2018	$6.31	$23.23	$30.29	$37.32	$99.63			$1.91	$5.16	$3.37	$4.15	$4.92			$5.05
6/16/2018	$30.00	$22.96	$35.79		$99.63			$9.09	$5.10	$3.98		$4.92			$4.67
6/17/2018		$23.34	$24.25						$5.19	$2.69					$4.62
6/18/2018		$22.88	$28.91	$38.43	$95.99				$5.08	$3.21	$4.27	$4.74			
6/19/2018	$27.22	$23.58	$33.02	$38.52	$91.53			$8.25	$5.24	$3.67	$4.28	$4.52			$4.57
6/20/2018		$21.95	$32.43		$103.09				$4.88	$3.60		$5.09			$4.63
6/21/2018	$23.55	$20.38	$21.43	$36.54	$91.73			$7.14	$4.53	$2.38	$4.06	$4.53			$5.00
6/22/2018	$30.00	$21.35	$29.95					$9.09	$4.74	$3.33					
6/23/2018	$23.80	$17.03	$31.68	$36.54	$91.53			$7.21	$3.78	$3.52	$4.06	$4.52			$3.46
6/24/2018		$22.69	$28.74						$5.04	$3.19					
6/25/2018	$24.00	$18.30	$18.00					$7.27	$4.07	$2.00					$3.84
6/26/2018	$20.30	$18.52	$26.54	$36.54	$76.75			$6.15	$4.12	$2.95	$4.06	$3.79			$4.00
6/27/2018	$8.72	$17.22	$32.95	$26.91	$77.15			$2.64	$3.83	$3.66	$2.99	$3.81			$3.90
6/28/2018	$30.00	$17.51	$30.27	$21.96				$9.09	$3.89	$3.36	$2.44				
6/29/2018	$30.00	$17.96	$24.00	$21.96				$9.09	$3.99	$2.67	$2.44				$3.30
6/30/2018	$4.00	$17.52		$21.96				$1.21	$3.89		$2.44				$3.32
7/1/2018		$17.27							$3.84						
7/2/2018	$10.00	$18.48	$26.73					$3.03	$4.11	$2.97					$3.29
7/3/2018		$17.43		$18.63					$3.87		$2.07				$3.32
7/4/2018		$23.47							$5.22						$2.81
7/5/2018		$19.52	$19.62	$19.80					$4.34	$2.18	$2.20				$2.67



Type	Org
Package	6.0 oz

Row Labels	Values Sum of Inv Lbs	Sum of Ship Lbs	Sum of Sales Value	Average of Cents/lb
3/25/2018	296,118	275,805	1,868,057	$ 6.77
4/1/2018	505,319	378,684	2,354,125	$ 6.22
4/8/2018	613,251	718,068	4,017,646	$ 5.60
4/15/2018	617,622	576,144	3,481,393	$ 6.04
4/22/2018	512,474	563,094	3,408,989	$ 6.05
4/29/2018	454,047	467,518	2,811,485	$ 6.01
5/6/2018	418,731	483,781	2,724,458	$ 5.63
5/13/2018	316,935	316,188	1,745,384	$ 5.52
5/20/2018	352,585	358,252	1,999,578	$ 5.58
5/27/2018	474,656	437,616	2,306,520	$ 5.27
6/3/2018	272,782	284,983	1,453,841	$ 5.18
6/10/2018	233,046	263,268	1,362,150	$ 5.23
6/17/2018	171,514	228,413	1,189,297	$ 5.21
6/24/2018	150,482	151,751	698,798	$ 4.60
7/1/2018	106,187	117,971	469,402	$ 3.98
7/8/2018	42,633	66,447	284,192	$ 4.28
7/15/2018	25,790	27,629	89,171	$ 3.23
Grand Total	**5,564,168**	**5,715,608**	**32,264,489**	**$ 5.32**

INSTRUCTIONS:

This is an interactive chart. Select the TYPE and PACKAGE style or multiple selections to view the BMRIC values for the your data slice. You can select the TYPE and PACKAGE in either the chart filters or the table filters - both the table and the chart will display the selection.

EDUCATION COMMITTEE

FSMA REPORT

The California blueberry industry continuously strives to produce a healthy and safe product. Through its work in pest, disease, and standardization, the CBC continues to partner with other entities to represent the industry on critical issues.

The Food Safety Modernization Act (FSMA) was signed into law on January 4th, 2011, by President Barack Obama. The purpose of the law mandates the U.S. Food and Drug Administration (FDA) to implement a “comprehensive, science-based, preventative control across the food supply.” The FSMA rules are put in place to ensure specific actions that must be taken at each of the following points to prevent contamination. For several years, the Administration drafted several new rules including: Mitigation Strategies to protect Food Against Intentional Adulteration, Sanitary Transportation of Human and Animal Food, Produce Safety Rule, Foreign Supplier Verification Program, Accredited Third-Party Certification, Preventative Controls for Human Food, and Preventative Controls for Food for Animals. Although these rules have been drafted, guidance documents are still being formulated. The FDA has made it clear that the Administration plans to do an education roll out to assist growers, packers, and handlers on the implementation of the Act.

January 2018 marks a big milestone for FSMA in relation to large farms ($500,000 or more in revenue) when the Produce Safety Rule comes into force for these individuals on January 28, 2019. This rule will come into effect for smaller farms in January 2020. Fortunately for large growers, the first year of the rule will focus less on regulation and compliance, but more on education and readiness. With that, On-Farm Readiness Reviews are available for growers to test their preparedness for FSMA. With these reviews, growers voluntarily allow a team of state/federal regulators to work with them to ensure they are prepared for rule implementation. Please see the following pages for more detailed information regarding the On-Farm Readiness Review program.

Finally, the CBC will continue to update the industry as these new guidance documents are released. For more information, please visit the following link to view the most recent publication of the rules for the Food Safety Modernization Act: https://www.fda.gov/Food/GuidanceRegulation/FSMA/

May 30, 2018

Re: Produce Safety Program Website

Dear California Produce Associations:

The California Department of Food and Agriculture is pleased to inform you our new Produce Safety Program (PSP) has launched a website that will serve as a resource to California farmers who must comply with new regulations under the Produce Safety Rule (PSR).

The website, which can be found at www.cdfa.ca.gov/producesafety, includes basic information about the PSP and our efforts to help California produce farmers understand how to comply with the requirements of the PSR under the Food Safety Modernization Act (FSMA).

Our hope is that you will use this website and share it with your grower-members as the official resource for information about PSR implementation in California. Additional information will be added to the site in coming months. Currently, California produce farmers can use the website to learn about mandatory Produce Safety Rule Grower training that is required of at least one employee on every produce farm. Our website provides access to registration information for several courses being offered throughout the state that are subsidized by the U.S. Food and Drug Administration so that farms can complete the required training at a reduced price.

The site provides California produce industry members with some initial information about the upcoming PSP inspections that will be conducted by our staff on behalf of the FDA beginning in spring of 2019. To prepare for inspections, the Department is offering on-farm readiness reviews. Growers can schedule a review directly from the website. A Frequently Asked Questions section has been developed, along with some talking points that can be used to explain the new program to consumers. A regular blog is also part of the website and will be used to provide updates on program activities and resources.

In addition to the website, a Facebook page has been created for the program under @CDFAProduce Safety. Interested industry members can also join a mailing list to receive updates and information.

It is estimated over 20,000 farms in California are covered under the PSR, and we will need your assistance in reaching this audience with important information about the new regulation. We encourage your organization to share these new resources with your membership. We also welcome any questions you may have.

Sincerely,

Karen Ross, Secretary
California Department of Food and Agriculture

Enclosures

cc: Natalie Krout-Greenberg, Director
Inspection Services Division

Steve Patton, Branch Chief
Inspection Services Division

Shelley Phillips, Supervising Senior Environmental Scientist
Produce Safety Program

FDA U.S. FOOD & DRUG ADMINISTRATION
OFFICE OF REGULATORY AFFAIRS

September 13, 2017

Steve Patton
Branch Chief
1220 N Street
Sacramento, CA 95814

Dear Mr. Patton:

On September 12, 2017, the Food and Drug Administration (FDA) announced a postponement of the implementation of routine inspections of farms subject to the Produce Safety Rule until spring 2019. The announcement also addressed the extension of the compliance date for agricultural water standards and described how FDA will work with stakeholders to modify agricultural water standards in the future.

In light of this announcement, we are modifying the approach outlined in the cooperative agreements so that routine inspections will begin in spring 2019. This will allow states and FDA an opportunity to focus on issuing guidance and training plans, along with conducting On-Farm Advisory (Readiness) Reviews (OFRRs) in 2018. "For-cause" inspections (such as those related to outbreak investigations) will still occur, as needed, and will not change in light of this announcement. The new routine inspection timeline is as follows:

- Large Farms
  - Compliance Date - 1/26/2018; Inspection Start Date – March - June 2019
- Small Farms
  - Compliance Date - 1/28/2019; Inspection Start Date – March - June 2020
- Very Small Farms
  - Compliance Date - 1/27/2020; Inspection Start Date – March - June 2021

We ask that all State Produce Implementation Cooperative Agreement Program (CAP) grantees adjust their inspection implementation timelines according to the above schedule and reassess their strategic plans and budgets to determine the impact of these decisions, if any. We encourage states to consider reprogramming resources planned for inspections in 2018 to conducting OFRRs.

FDA, working closely with our association partners, is scoping out all activities that can be performed in lieu of routine inspections in Year 2. We will also be finalizing CAP-related information and decisions necessary to implement inspections in 2019. We will share this information with you no later than November 1, 2017, so you will have time to revise your strategic plans and budgets, if necessary, and submit them, along with your mid-year progress reports, by December 1, 2017.

While reassessing your program's strategic plan and budget please be mindful that all other planned activities under your existing cooperative agreement will continue including:

- Developing and continually updating your strategic plan for produce safety (continuation from Year 1)
    - Developing, documenting, and tracking performance measures
- Conducting a jurisdictional self-assessment (continuation from Year 1)
- Establishing and verifying a farm inventory (continuation from Year 1)
- Conducting legislative research and continuing any efforts to obtain regulatory authority (continuation from Year 1)
- Developing program and program infrastructure (continuation from Year 1 and/or new)
    - Developing and implementing a continuing education program to ensure regulatory jurisdiction personnel are trained
    - Establishing ties with FDA's Produce Safety Network and FDA's Technical Assistance Network to ensure that any questions or issues are raised and state/territory regulators receive necessary technical assistance
    - Researching, designing, and implementing a compliance program for applicable produce safety regulations at the jurisdictional level, which includes:
        - Continuing program development work, but adjusting for the new targeted start date; and
        - Delaying implementation of the inspection program and redirecting those resources to OFRRs and other education and outreach programs
    - Continuing communication and collaboration amongst CAP stakeholders
- Performing education and outreach (continuation from Year 1 and/or new)
    - Evaluating educational needs and implementing an educational system to provide for an informed farming community
    - Participating in and providing opportunities for OFRRs

The implementation of the Food Safety Modernization Act (FSMA) and the Produce Safety Rule has been and continues to be a top priority for FDA. As you know, states have a long history of effectively working with and understanding your farming communities. Successful implementation of the Produce Safety Rule cannot happen without the support of our state partners who are helping food producers and growers understand and achieve the new requirements.

FDA is committed to ensuring our regulatory partners and industry have the tools needed to implement the new standards. As we continue to work together with FSMA implementation, we recognize that achieving our shared food safety goals is a continuous effort from all of us.

Thanks for your commitment to integration and food safety. We look forward to our continued partnership.

part 112, or the FSVP regulation are still required to make necessary disclosures. Subsequent entities in the distribution chain will continue to be subject to applicable requirements related to food adulteration in Federal and/or state and local laws and regulations, e.g., part 117, part 507, and the Retail Food Code.

C. Enforcement Policy for Importation of Food Contact Substances Under the FSVP Regulation

The FSVP regulation requires food importers to develop, maintain, and follow an FSVP that provides adequate assurances that the foreign supplier uses processes and procedures that provide the same level of public health protection as those required under the preventive controls or produce safety provisions of FSMA (if applicable) and regulations implementing those provisions, as well as assurances that the imported food is not adulterated and that human food is not misbranded with respect to allergen labeling (21 CFR 1.502(a)). Among other things, the FSVP regulation (21 CFR 1.500-1.514) requires most food importers to do the following:

- Analyze the hazards for the foods they import (21 CFR 1.504);
- Evaluate the performance of their potential foreign suppliers and the risk posed by the foods to be imported (21 CFR 1.505); and
- Determine and conduct appropriate foreign supplier verification activities, such as onsite auditing of foreign suppliers, sampling and testing, and review of supplier food safety records (21 CFR 1.506).

The FSVP regulation applies (with certain exceptions) to the importation of food as defined in section 201(f) of the FD&C Act (see 21 CFR 1.500). Food contact substances are included in the definition of "food" for purposes of the FSVP regulation (21 CFR 1.500). However, for the reasons stated below, we intend to exercise enforcement discretion for importers of food contact substances with respect to the FSVP regulation.

A food contact substance is any substance that is intended for use as a component of materials used in manufacturing, packing, packaging, transporting, or holding food if such use of the substance is not intended to have any technical effect in such food (section 409(h)(6) of the FD&C Act (21 U.S.C. 348(h)(6)); 21 CFR 170.3(e)(3)). The term "food" is defined in section 201(f)(3) of the FD&C Act to include articles used as components of food. In the preamble to the FSVP final rule, we stated that the definition of "food" for purposes of FSVP includes food contact substances that are considered "food" in section 201(f) of the FD&C Act (80 FR 74225 at 74233). Therefore, the FSVP regulation applies to importers of food contact substances that meet the definition of "food" in section 201(f).

In the compliance date final rule, we extended the compliance date for the importation of food contact substances by 2 years so that we could consider how best to address concerns raised about the feasibility of importers of food contact substances meeting the FSVP requirements (81 FR 57784 at 57792-57793). As a result of this extension, the earliest that an importer would be required to comply with FSVP for the importation of food contact substances would be May 28, 2019.

- Subpart C of part 507 includes provisions for disclosure statements and written assurances that apply when a manufacturer/processor of food for animals identifies a hazard requiring a preventive control, does not control the identified hazard, and relies on an entity in its distribution chain to control the hazard (§§ 507.36(a)(2), (3), and (4), 507.36(c), 507.36(d), and 507.37). A manufacturer/processor that complies with these provisions of part 507 is not required to implement a preventive control for the identified hazard. The combination of these requirements was intended to provide assurance that the food will be processed to control the identified hazard before it reaches the consumer feeding the food to animals.
- Subpart F of part 507 specifies the elements to be included in the written assurances required by § 507.36(a)(2)(ii), (3)(ii), and (4)(ii). (See § 507.215(b).)

The FSVP regulation includes "customer provisions" that apply when an importer imports a food for which the hazards are controlled after importation (§ 1.507). As with the customer provisions in part 117 and part 507, the requirements in the customer provisions of the FSVP regulation were intended to provide assurance that the food will be processed to control the identified hazard before it reaches the humans or animals that would consume the food.

The produce safety regulation applies to "covered produce" as set forth in §§ 112.1 and 112.2. Produce that would otherwise be covered is eligible for an exemption from most of the requirements of the produce safety regulation if: (1) The produce receives commercial processing that adequately reduces the presence of microorganisms of public health significance (§ 112.2(b)(1)); and (2) certain other conditions are met, including requirements for disclosure statements and written assurances analogous to the requirements for disclosure statements and written assurances in the "customer provisions" required by part 117, part 507, and the FSVP regulation (§ 112.2(b)(2) through (4) and (6)).

FDA has received feedback from industry expressing concern that certain product distribution chains would require vastly more written assurances (and consequently resources to comply with the requirement) than anticipated by FDA during the rulemaking process (Ref. 1). For example, a manufacturing facility may sell food products subject to the customer provisions to a distributor, who may sell numerous items requiring assurances to multiple restaurants, cafeterias, delicatessens, and other distributors. It is estimated that this could result in hundreds or even thousands of written assurances needed by a single distributor (Ref. 1). After considering this feedback from industry, we stated our belief that the requirement for written assurance in the customer provisions of part 117 significantly exceeds the current practices of even the largest facilities; compliance by those facilities by September 19, 2016, may not be feasible; and it is appropriate to extend the compliance dates for 2 years for the written assurance requirements for part 117, part 507, the FSVP regulation, and the produce safety regulation while we considered the best approach to address feasibility concerns (81 FR 57784 at 57786).

FDA intends to initiate a rulemaking that takes into consideration the complex supply chain relationships and resource requirements. To provide sufficient time for us to pursue that rulemaking, we are exercising enforcement discretion with regard to the written assurance requirements of part 117, part 507, part 112, and the FSVP regulation until completion of that rulemaking process. In the meantime, entities with disclosure duties under part 117, part 507, squash, winter; sweet potatoes; and water chestnuts.

(2) Produce that is produced by an individual for personal consumption or produced for consumption on the farm or another farm under the same management; and

(3) Produce that is not a raw agricultural commodity.

(b) Produce is eligible for exemption from the requirements of this part (except as noted in paragraphs (b)(1), (2), and (3) of this section) under the following conditions:

(1) The produce receives commercial processing that adequately reduces the presence of microorganisms of public health significance. Examples of commercial processing that adequately reduces the presence of microorganisms of public health significance are processing in accordance with the requirements of part 113, 114, or 120 of this chapter, treating with a validated process to eliminate spore-forming microorganisms (such as processing to produce tomato paste or shelf-stable tomatoes), and processing such as refining, distilling, or otherwise manufacturing/processing produce into products such as sugar, oil, spirits, wine, beer or similar products; and

(2) You must disclose in documents accompanying the produce, in accordance with the practice of the trade, that the food is "not processed to adequately reduce the presence of microorganisms of public health significance;" and

(3) You must either:

(i) Annually obtain written assurance, subject to the requirements of paragraph (b)(6) of this section, from the customer that performs the commercial processing described in paragraph (b)(1) of this section that the customer has established and is following procedures (identified in the written assurance) that adequately reduce the presence of microorganisms of public health significance; or

(ii) Annually obtain written assurance, subject to the requirements of paragraph (b)(6) of this section, from your customer that an entity in the distribution chain subsequent to the customer will perform commercial processing described in paragraph (b)(1) of this section and that the customer:

(A) Will disclose in documents accompanying the food, in accordance with the practice of the trade, that the food is "not processed to adequately reduce the presence of microorganisms of public health significance"; and

(B) Will only sell to another entity that agrees, in writing, it will either:

(*1*) Follow procedures (identified in a written assurance) that adequately reduce the presence of microorganisms of public health significance; or

(*2*) Obtain a similar written assurance from its customer that the produce will receive commercial processing described in paragraph (b)(1) of this section, and that there will be disclosure in documents accompanying the food, in accordance with the practice of the trade, that the food is "not processed to adequately reduce the presence of microorganisms of public health significance"; and

(4) You must establish and maintain documentation of your compliance with applicable requirements in paragraphs (b)(2) and (3) in accordance with the requirements of subpart O of this part, including:

(i) Documents containing disclosures required under paragraph (b)(2) of this section; and

(ii) Annual written assurances obtained from customers required under paragraph (b)(3) of this section; and

(5) The requirements of this subpart and subpart Q of this part apply to such produce; and

(6) An entity that provides a written assurance under §112.2(b)(3)(i) or (ii) must act consistently with the assurance and document its actions taken to satisfy the written assurance.

§ 112.3 What definitions apply to this part?

(a) The definitions and interpretations of terms in section 201 of the Federal Food, Drug, and Cosmetic Act apply to such terms when used in this part.

(b) For the purpose of this part, the following definitions of very small business and small business also apply:

(1) *Very small business.* For the purpose of this part, your farm is a very small business if it is subject to any of the requirements of this part and, on a

FSMA Produce Safety Rule

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

What Produce Associations Need to Know

- California Department of Food Agriculture (CDFA) is launching the California Produce Safety Program, which will include educational information designed to assist California produce farms in understanding the requirements of the FDA's Produce Safety Rule and how to comply with this new regulation.
- Beginning January 26, 2018, California produce farms designated as "large" (those with annual sales greater than $500,000) are expected to comply with the Produce Safety Rule. Smaller farms will be phased in over the next few years.
- The Produce Safety Rule is mandatory throughout the United States beginning January 26, 2018. Any produce farm found to be out of compliance may be subject to regulatory actions.
- In 2018, the Produce Safety Program will be doing everything possible to inform and educate California produce farmers about the requirements of the Produce Safety Rule.

Who Must Follow the Produce Safety Rule?

- California farms producing fruits, nuts and vegetables must comply with this new rule.
- Multiple rules exist within the federal Food Safety Modernization Act (FSMA). The Produce Safety Program deals specifically with the Produce Safety Rule. Information about other FSMA Rules is available here.
- The exact rule an operation falls under will vary depending upon the type of activities performed. To determine if an operation falls under the Produce Safety Rule, please use this flow chart provided by The National Sustainable Agriculture Coalition.

CDFA Produce Safety Program Website Coming Soon

www.cdfa.ca.gov/producesafety/

CDFA is currently developing a new Produce Safety Program website. This will serve as the go to place for individuals looking for PSR information.

cdfa PRODUCE SAFETY PROGRAM

Who is Exempt from the Produce Safety Rule?

- A list of exemptions from the Produce Safety Rule can be found here. Exemptions generally include the following:
- Thirty commodities have been identified by the FDA as exempt from the Produce Safety Rule because they are rarely consumed raw. Farms exclusively producing these commodities are not covered by the Produce Safety Rule. (Examples of exempt commodities include: dried kidney beans, potatoes and pumpkins.)
- Farms that grow produce only for personal consumption or very limited distribution may also be exempt from the law.
- Some farms may qualify for an exemption from the Produce Safety Rule if their sales are below certain levels or if they grow produce that is processed in a way that would kill pathogens. Farms falling in these categories will be required to verify their exemption status.
- If your organization represents commodities that may be eligible for a qualified exemption because the finished product is processed in a way that kills pathogens, CDFA strongly urges you to seek guidance from FDA regarding documentation requirements to verify this exemption.
- CDFA is also urging associations to work with industry members to ensure procedures for documentation for qualified exemptions required of both farmers and processers are well understood and communicated.

Education and Training

- FDA has determined that official Produce Safety Rule on farm inspections will begin in 2019. The Produce Safety Program will spend 2018 working to make sure California produce farmers understand the requirements of the Produce Safety Rule.

- An informational website providing detailed information on the Produce Safety Program will be available soon and CDFA will be conducting other outreach efforts to educate California produce farms about this new rule and how to comply.

- One of the first steps toward Produce Safety Rule compliance is for every produce farm to have an individual employed who has completed an FDA-recognized Produce Safety Rule Grower Training Course. The training need only be taken once and the certificate of completion belongs to the individual. Available courses are posted on the Produce Safety Alliance website here.

- CDFA has also contracted with outside organizations to provide subsidized Grower Training that meets Produce Safety Rule requirements. These courses are offered at a reduced rate and are being conducted throughout the state in both English and Spanish. A list of dates and locations of these courses is provided with this packet.

- In addition to the required Produce Safety Rule Grower Training, all produce farms must show documentation of ongoing food safety training of farm and contracted employees as part of the required practices under the Produce Safety Rule.

- Any information or assistance your association can provide to ensure farmers are meeting Produce Safety Rule training requirements is greatly appreciated.

- In preparation for official Produce Safety Rule inspections in 2019, CDFA's Produce Safety Program will be offering a series of On-Farm Readiness Reviews (OFRR). These are designed to give produce farmers a better understanding of what they can expect from a Produce Safety Program routine inspection. Information on how to schedule an OFFR will be available very soon.

Information for the Public and Other Stakeholders

- Please note that California Produce Safety Program inspections are a means of verifying compliance and enforcement of the Produce Safety Rule. They are not meant to replace existing quality assurance activities that may be requested of farmers or handlers by their customers.

- Suggested messaging for use in talking about the Produce Safety Program with trade and consumers is included in this packet.

- CDFA urges you to share information contained in this packet with your membership.

Implementation of Required Food Safety Practices

- Produce farms with sales greater than $500,000 per year are expected to implement Produce Safety Rule practices beginning January 26, 2018. The full Produce Safety Rule requirements are available on the FDA website here.

- If your association has commodity specific guidelines that are aligned with the Produce Safety Rule, we encourage you to share these with your membership.

- We also urge you to advise your membership that private audit firms should conduct audits that are aligned with the Produce Safety Rule so that farmers are well prepared for Produce Safety Program inspections when they begin taking place in 2019.

Produce Safety Program Inspections

- CDFA has created a new unit as part of its Inspection Services Division specifically to conduct Produce Safety Rule inspections. This unit is known as the Produce Safety Program.

- Produce Safety Rule inspections will be done on behalf of the U.S. FDA. As such, Produce Safety Program inspectors are credentialed by the FDA and have specific education and training.

- As with all other programs within the CDFA's Inspection Services Division, Produce Safety Program inspectors are part of a public agency mandated to protect the food supply. Inspectors are: accountable to the public, legislature and the industry; financially independent and unbiased; consistent and uniform; and are required to report potential public health threats to the California Department of Public Health.

- CDFA is working with an existing database of California farms acquired from other agencies and organizations to identify California produce farms that are likely subject to this new rule. Farms from this list will be selected for routine inspection by the Produce Safety Program on a random basis following verification of the farm's status.

cdfa PRODUCE SAFETY PROGRAM

Suggested Messaging for Retail and Foodservice Produce Buyers

cdfa PRODUCE SAFETY PROGRAM

About the Produce Safety Rule

- Beginning January 26, 2018, the Produce Safety Rule under the new Food Safety Modernization Act will become law on produce farms throughout the U.S.

- All California farms producing fruits, nuts and vegetables must comply with this new law. Some exceptions apply. Your supplier can provide verification if they are exempt from the Produce Safety Rule.

- The law will be phased in according to farm size over the next few years beginning in 2018 with large farms, defined as those with annual sales of $500,000 or more.

- To implement this new law across the nation, the U.S. FDA is working with State Departments of Agriculture to conduct inspections that will verify produce farms are in compliance with the Produce Safety Rule.

- The U.S. FDA has determined that Produce Safety Rule on-farm inspections will begin in 2019.

Implementation in California

- It is estimated some 20,000 produce farms in California are subject to the Produce Safety Rule.

- The California Department of Food and Agriculture has created a new unit as part of its Inspection Services Division specifically to conduct inspections that will verify compliance with the Produce Safety Rule. This unit is known as the Produce Safety Program.

- The goal of CDFA's Produce Safety Program is to assist and verify that California produce farms are following FDA's Produce Safety Rule.

- This is a big job and it will take time to fully implement. CDFA's goal is for Produce Safety Rule requirements to become ingrained in the culture of California produce farming so that our state is growing the safest produce possible.

- The California Produce Safety Program's role is to first educate California produce farmers on the requirements of the Produce Safety Rule and then regulate farms to ensure they are following this new rule.

About the Produce Safety Program Inspections

- California Produce Safety Program inspections are a means of verifying compliance and enforcement of the Produce Safety Rule. They are not meant to replace existing quality assurance activities provided by farmers or handlers.

- Beginning in 2019, California produce farms will be selected for inspection by the Produce Safety Program on a random basis following verification of the farm's status.

- Unlike audit based certification programs, farms may not request an inspection, but will instead be selected by the Produce Safety Program.

Suggested Messaging for Consumers

cdfa PRODUCE SAFETY PROGRAM

About New Food Safety Regulations for Produce

- Beginning on January 26, 2018 fruit, vegetable and nut farms in California and throughout the U.S. will be required to follow specific food safety practices under a new federal regulation known as the Produce Safety Rule.

- The U.S. Food and Drug Administration (FDA) has been charged with oversight of this new rule and it is being implemented in California by the California Department of Food and Agriculture (CDFA).

- Food safety practices required on farms are similar to what is required of restaurants or to precautions you might take in your own kitchen. The practices are designed to ensure produce is properly handled by workers who are trained to use good hygiene; to make sure farm equipment is sanitary, to ensure soils where produce is grown are safe and, that measures are in place to prevent contamination of produce by wildlife or nearby domesticated animals. Additionally, farmers are required to keep written records to document their farming practices.

- Many produce farms have been implementing these kinds of food safety practices on their farms for years.

What Consumers Can Expect from Produce Grown in California

- Routine on-farm Inspections to verify farmers are following new food safety regulation will be conducted through an inspection unit created by the California Department of Food and Agriculture called the Produce Safety Program.

- It's estimated that 20,000 farms in California are subject to the Produce Safety Rule. It is the goal of CDFA that requirements of this new food safety rule become ingrained in the culture of California produce farming so that our state is growing the safest produce possible.

- Over the next year, the role of the California Department of Food and Agriculture's Produce Safety Program will be to educate California produce farmers about the requirements of the Produce Safety Rule.

- Beginning in 2019, CDFA's Produce Safety Program inspectors will conduct random, routine inspections of produce farms to ensure they are following the new law.

- Inspectors in California are credentialed by the FDA and have specialized education and training. The inspectors are part of a government agency charged with protecting the food supply. They provide independent, unbiased, consistent inspections of California produce farms.

- Most grocery stores and restaurants already require farmers to follow food safety practices on their farms. In addition, many organizations conduct research and provide food safety guidelines that produce farmers have been following for years.

- Requirements for produce safety on farms is now the law. Farmers found to be out of compliance with these new requirements may face economic, regulatory and legal consequences.

On-Farm Readiness Review

Introduction

The walk around questions (WAQ) are intended to help assessor(s) solicit information from the grower. It is not intended to cover all aspects of the Produce Rule, but what is considered the most important portions. The WAQ is to be used with the OFRR Resource Manual. The assessor(s) should have a good understanding of the produce rule and the manual before doing any readiness reviews.

The assessor should first talk to the grower about what portions of the Produce Rule apply to them. Use the OFRR Decision Tree which is located at Tab 4 in the manual. This will allow you and the grower to determine which parts to use for the walk through. Each Tab in the manual from 4-15 covers a different section of the Rule with a corresponding WAQ. The WAQ documents are setup as a series of questions. At the start of most questions is a section number in brackets i.e. [112.51] which refers directly to the Rule under that tab in the manual. If a written document is required, the section number will be followed by a capital D in parenthesis i.e. (D).

At the end of the walk through the assessor(s) should meet with the grower to review what was observed and make suggestions for improvement. The goal is not to point out everything that the grower may need to change, but the most important changes needed.

On-Farm Readiness Review

Walk Around Questions (WAQ)

Health and Hygiene (Tab 4)

Potential locations – immediately upon arrival if asked to sign an acknowledgment of food safety practices document, employee break area, hand wash station, restroom

[112.31]; How do you prevent ill or persons you suspect of being sick from coming into contact with produce and food contact surfaces?

[112.32]; What sort of hygiene expectations do you have for all your employees? Do you have glove, jewelry, or other similar policies?

[112.33]; What are your visitor policies or procedures related to health and hygiene.

Walk Around Questions (WAQ)

Preharvest Biological Soil Amendments of Animal Origin (5)

Potential locations – compost pile, compost storage, composting area

[112.52(a), 112.52(b)]; Does your farm use any soil amendments of animal origin, including agricultural tea?

[112.52]; If yes, how is it stored and handled prior to application?

[112.51(b)(5), 112.54] (D); Do you test the water for the tea and if so what for?

Do you spike the tea with anything (nutrients or other additives)?

[112.51, 112.54]; What type of soil amendments do you use? (Note to assessors: probe deeper regarding use of human waste, sewage sludge biosolids, manure, compost, bone meal, feather meal, fish emulsion, table waste, pre-consumer vegetative waste, etc.)

[112.52] When do you apply your amendments?

[112.56]; Do they contact the harvestable portion of the crop during or after application?

[112.56(a)(1)(i)]; How long do you wait before harvesting after application?

[112.53] (D); Does your farm use any human waste or sewage sludge biosolids?

[112.60(b)(1), 112.60(b)(2)] (D); Do you produce your own compost or purchase it pre-treated?

[112.60(b)(1)] (D); If you buy treated compost amendments, do you maintain a certificate or document from that supplier the microbial quality of the product at least annually?

[112.54, 112.55]; Is the process used to treat it scientifically valid (Ex.'s physical process (ex. thermal), chemical process (ex. High alkaline pH), biological process (Ex. composting) or a combination of these, and validated to show no detectable *Listeria monocytogenes*, *Salmonella* species and fecal coliforms or *E. coli* O157:H7 for purchased compost?

If you produce your own compost, where do you produce it and how is it stored?

[112.60(b)(1)(i)], [112.60(b)(1)(iii)], (D); Do you have a record of the process used to treat the amendment?

[112.60(b)(1)(ii)] (D); Do you have a record of the handling and storage of the amendment?

Walk Around Questions (WAQ)

Preharvest and Harvest Wild and Domestic Animals (Tab 6)

Potential locations – working animals, animal deterrents, walking field perimeter

[112.81]; Does your farm operation grow, pack or hold produce in an outdoor area or partially enclosed building? (May be obvious upon visiting farm operation)

[112.83]; Does your farm use grazing animals, working animals, or have animals entering production areas during the season?

[112.83(a)]; What steps do you take if you suspect that grazing animals, working animals, or animal intrusion will contaminate covered produce?

[112.83(b)]; How do you assess potential contamination during the season?
[112.112]; If contamination is found, how do you evaluate whether produce can be harvested?

* [112.22(b)(1); 112.30(b)]; What type of training do workers receive on dealing with contaminated produce at harvest?

On-Farm Readiness Review

Walk Around Questions (WAQ)

Preharvest Worker Training (Tab 7)

Potential locations – employee break area, hand wash station, restroom

*[112.21(a), 112.22(a)(1); When do you train your workers on hygiene? What do you cover? How often do you retrain? How do you handle new employees during the season?

*[112.21(b)]; What type of training to you or the supervisors of the workers receive?

*[112.22(b), 122.22(b)(3)]; Do you give different types of training for your field and packinghouse crews? If so what?

*[112.30] (D); Do you keep records of your trainings?

*[112.129]; What type of toilet facilities and handwashing stations do you provide?

*[112.130]; What supplies are included with the toilets and handwashing facilities

*[112.129(b)(2)]; How are they serviced?

*[112.129(b)(1), 112.131(c)]; What do you do if a portable toilet leaks, tips, or spills?

*[112.129(a)]; Where are toilets in relation to the work being done and how many do you have?

On-Farm Readiness Review

Walk Around Questions (WAQ)

Preharvest Sanitation (Tab 8)

Potential locations – production equipment, chemical storage, walking the field

[112.111]; Do you grow crops that are covered and not covered under the produce rule? If so, do you clean any shared equipment before using on covered produce?

[112.112]; Do you do a preharvest inspection of the growing area? What do you look for? What are your corrective actions if you find a problem? How do you ensure contaminated produce will not be harvested?

[112.123] (D); Do you inspect and maintain equipment, and when necessary clean and sanitize equipment used in the field before harvest? (Distinguish between cleaning and sanitizing). How do you do it? What sort of sanitizer do you use? How often?

112.140]; Do you keep records of equipment sanitation?

[112.132] How do you dispose of waste in the field to prevent contamination of produce and ag water?

On-Farm Readiness Review

Walk Around Questions (WAQ)

Preharvest Water (Tab 9)

Potential locations – water source (well or surface), water treatment system, distribution system

How do you use water before the harvest of crops on your farm (i.e., is it considered *agricultural water*)?

[112.42(a)(1)] (D); What are the sources of water used throughout the season [Municipal, Groundwater (i.e., wells), Surface Water (lakes, ditches, rivers or streams), How many?]?

Think about all the water used for irrigation, crop protection, frost protection, and dust abatement. How do the sources change during different times of year or with how you use the water?

[112.42(a)] (D); Do you inspect your water system? If so how often? What things do you look for in the inspection? (Ask the grower to walk through a typical inspection with you.)

[112.42(a)(4)] (D); What are the specific activities near the source or through the conveyances that impact the quality of these water sources (On this farm, from adjacent land)? How likely will these activities contaminate the water source?

[112.42(c)]; How do you protect your water sources? (physical access, backflow prevention)

[112.46] (D) How do you assess water quality for preharvest uses? Testing? How frequently and when? What test(s) [target organism, testing method] are you using? Do you know what your water unit testing is?

[112.47(b)]; How do you take your water samples?

Note: Exact requirements listed below are under review by FDA and may change. Also, water requirements do not go into effect for four years after implementation dates based on produce sales.

Municipal Source (a record of the annual testing from the municipality)
Ground water sources (4 tests total with 1 per year, per source)
Surface water sources (20 tests total with 5 per year, per source)

[112.44(b)] (D); Are you calculating a Geometric mean and STV?

[112.44(b)] (D); Does your water meet the *E. coli* criteria established in the PSR? (<126 CFU GM & <410 CFU)?

[112.45]; If your water happened to exceed the *E. coli* criteria, what corrective measures would you use to lower the risk?

[112.45(a)(1)] (D); If it did exceed the criteria, did you reinspect the system to look for problems before performing a corrective action?

* [112.45(b)(1)(i)(A)] (D); Are you applying a preharvest interval? How many days?

(D) Does your crop go to commercial processing? Is your buyer aware that risky produce (ie.high micro load water application preharvest) needs to be handled differently?

[112.45(b)(1)(ii)] (D); Postharvest treatment or storage? Do you have a validation to show its efficacy?
[112.45(b)(2)] (D); Re-inspecting the water system?
* [112.45(a)(2)] (D); Do you treat the water? If so, how?

[112.45 (b)] (D); Have you had to take any Corrective Actions this season?

[112.12 (a)] (D); Do you use an alternative to a requirement?
[112.49 (a)] (D); Alternative microbial Indicator? Do you have scientific data to support it?
[112.49 (b)] (D); Alternative preharvest die-off? Do you have scientific data to support it?
[112.49 (c)] (D); Alternative minimum sample number in initial survey? Do you have scientific data to support it?
[112.49 (d)] (D); Alternative minimum sample number in annual survey? Do you have scientific data to support it?

Walk Around Questions (WAQ)

Harvest Worker Training (Tab 10)

Potential locations – employee break area, hand wash station, restroom, watching harvest

[112.112]; Do you inspect fields at harvest for signs of animal feces? What do you if feces in found on or around the produce?

[112.113]; How do you protect the produce from becoming contaminated during harvest?

[122.22(b)(2), 122.22(b)(3); What does a worker do if he/she fines containers that were not properly cleaned when harvesting?

[112.129]; What type of toilet facilities and handwashing stations do you provide?

[112.129]; How close are the toilet facilities located to the field during harvest?
[112.129(b)(2)]; How are they serviced?

[112.130]; What supplies are included with the toilets and handwashing facilities

[112.129(b)(1), 112.131(c)]; What do you do if a portable toilet leaks, tips, or spills?

[112.129(c); If you are growing in a greenhouse where are the toilets and handwashing stations located?

[112.21(a), 112.22(a)(1); When do you train your workers on hygiene? What do you cover? How often do you retrain? How do you handle new employees during the season?

[112.21(b)]; What type of training to you or the supervisors of the workers receive?

[112.21(c)]; How do you train workers that may not read or write or understand English?

[112.22(b), 122.22(b)(3)]; Do you give different types of training for your field and packinghouse crews? If so what?

[112.30] (D); Do you keep records of your trainings?

[112.22(a)(2); How do you inform visitors (including u-pick) as to the health and safety issues around the operation?

On-Farm Readiness Review

Walk Around Questions (WAQ)

Harvest Sanitation (Tab 11)

Potential locations – watching harvest, looking at harvest equipment, looking at where harvest equipment is stored or cleaned

[112.22(b)] (D); What type of training do you give to the harvest crew?

[112.22(b)(1)] (D); What instructions do you give to the harvest crew related to dropped produce or produce which may be contaminated with manure or other animal feces?

[112.111]; Do you grow crops that are covered and not covered under the produce rule? If so, do you handle and/or store the crops together or use any shared equipment?

[112.112]; Do you do a preharvest inspection of the growing area? What do you look for? What are your corrective actions if you find a problem? How do you ensure contaminated produce will not be harvested?

[112.113]; How do you handle harvested produce to prevent contamination?

[112.114]; How do you ensure dropped produce is not distributed?

[112.116]; Do you reuse packing / harvest containers? If so, how are they cleaned and sanitized?

[112.123] (D); How frequently do you inspect and maintain equipment, and when necessary clean and sanitize equipment used in the field before harvest? (Distinguish between cleaning and sanitizing). How do you do it? What sort of sanitizer do you use? How often?

112.140]; Do you keep records of equipment sanitation?

[112.125]; How do you ensure vehicles used to transport produce are cleanable (look for carpet, absorbent material, etc.), clean and/or sanitary?

[112.132] How do you dispose of waste in the field to prevent contamination of produce and ag water?

On-Farm Readiness Review

Walk Around Questions (WAQ)

Harvest Water (Tab 12)

Potential locations – water source, point of water use, during harvest

How do you use water (including ice) during the harvest of crops on your farm?
**[112.42(a)(1)] (D); What are your sources of water used at harvest?

Think about all the water used for equipment and direct food contact surface cleaning, hand wash water, for produce quality (freshening greens) and hydrocooling. How do the sources change during different times of year or with how you use the water?

**[112.42(a)] (D); Do you inspect your water system? If so how often? What things do you look for in the inspection? (Ask the grower to walk through a typical inspection with you.)

**[112.42(a)(4)] (D); What are the specific activities near the source or through the conveyances that impact the quality of these water sources (On this farm, from adjacent land)? How likely will these activities contaminate the water source?

**[112.42(c)]; How do you protect your water sources? (cross-connections, backflow prevention)

**[112.46] (D); How do you assess water quality for harvest uses? Testing? How frequently and when? What test(s) [target organism, testing method] are you using? Do you know what your water unit testing is? How do you take your water samples?

**[112.43] (D); Do you treat this water? If so, how?

**[112.45]; What do you do if a water test comes back higher than expected (a positive generic *E. coli* test)? How would you correct this on your farm?

[112.48(a)] Do you re-use or recirculate water? If so, how do you monitor recirculating water? How do you determine when it's time to change recirculated water?

> **[112.43] (D); Do you use an antimicrobial (sanitizer, uV)? How do you use them? How do you monitor their effectiveness? How frequently do you monitor it?
> (Depending on your sanitizer) How do you monitor the pH of this water?
>
> [112.48(b)]; Are you familiar with water turbidity? How do you gauge/measure this?
> [112.48(c)]; Based on what you harvest, is the temperature of the water a concern? How do you address it?

*[112.50(a)] (D); What documents do you keep related to your water sources, antimicrobial use, and testing?

On-Farm Readiness Review

Walk Around Questions (WAQ)

Postharvest Worker Training (Tab 13)

Potential locations – employee break area, hand wash station, restroom, watching packing

[112.129(a)]; Approximately how many workers do you have in the packinghouse?

[112.129(b)(1)]; Are there toilet facilities and handwashing stations available for the workers during produce packing and where are they located?
Who services the facilities and how frequently?

[122.22(b)(2), 122.22(b)(3); What does a worker do if he/she fines containers that were not properly cleaned after harvest?

[112.129]; What type of toilet facilities and handwashing stations do you provide?

[112.129]; How close are the toilet facilities located to the packing area?
[112.129(b)(2)]; How are they serviced?

[112.130]; What supplies are included with the toilets and handwashing facilities

[112.129(b)(1), 112.131(c)]; What do you do if a portable toilet leaks, tips, or spills?

[112.129(c); If you are growing in a greenhouse where are the toilets and handwashing stations located?

[112.21(a), 112.22(a)(1); When do you train your workers on hygiene? What do you cover? How often do you retrain? How do you handle new employees during the season?

[112.21(b)]; What type of training to you or the supervisors of the workers receive?

[112.21(c)]; How do you train workers that may not read or write or understand English?

[112.22(b), 122.22(b)(3)]; Do you give different types of training for your packinghouse crew? If so what?

[112.30] (D); Do you keep records of your trainings?

[112.22(a)(2); How do you inform visitors as to the health and safety issues around the operation and do you provide them with toilet and handwashing facilities?

On-Farm Readiness Review

Walk Around Questions (WAQ)

Postharvest Sanitation (Tab 14)

Potential locations –observe packing, observe cleaning/sanitation at packinghouse, chemical storage area, cold rooms and other storage areas

[112.111]; Do you harvest and handle both covered and non-covered produce? If so, do you separate covered and non-covered produce? If so, please describe separation (physical, time, handling, cleaning).

[112.113]; How do you handle produce that contacts the ground, packinghouse floor, or other non-food contact surface?

[112.123] (D); Do you clean and/or sanitize equipment?

- [112.123(d)(1)]; How do you clean equipment? Do you sanitize cleaned equipment? If so, how?
- [112.140]; Do you keep records? If so, what records?

[112.116]; How do you ensure your packaging materials are clean and sanitary?

- [112.116(a)]; How do you handle damaged or cracked containers?
- [112.115]; Does packaging allow for air flow?

[112.124]; Are you using any monitoring equipment i.e., temperature recorders, pH meters, etc.? If so, do you check their accuracy and how often?

[112.125]; How do you ensure vehicles used to transport produce are cleanable (look for carpet, absorbent material, etc.), clean and/or sanitary?

[112.126]; Are building drains, walls, ceilings and floors checked for leaks or other sources of contamination? How often are they cleaned? Are buildings adequate in size and construction (including adequate partitions and drainage)

- [112.126(a)(2)]; Is there standing water? If so, how is it addressed?
- [112.133]; Is plumbing sufficient?

[112.128]; Do you have a pest control program in place? If so, describe.

[112.127]; Are domestic animals allowed in the packinghouse?

[112.131]; What type of sewage system (septic, municipal, etc.) do you have for the packinghouse?

[112.132]; How often do you remove culled produce and trash from the packing area?

Walk Around Questions (WAQ)

Postharvest Water (Tab 15)

Potential locations – water source (well, connection to municipal), point of water use if during packing (hydrocooler, flume, dump tank, spray bar), sanitation

**[112.42(a)(1)] (D); What are your sources of water used during postharvest operations?
(Think about all the water used for equipment and direct food contact surface cleaning, hand wash water, dump tanks, ice making, fluming and hydrocooling.)

**[112.42(a)] (D); Do you inspect your water system? If so how often? What things do you look for in the inspection? (Ask the grower to walk through a typical inspection with you.)

**[112.42(a)(4)] (D); What are the specific activities near the source or through the conveyances that impact the quality of these water sources (On this farm, from adjacent land)? How likely will these activities contaminate the water source?

**[112.42(c)]; How do you protect your water sources (cross-connections, backflow prevention)?

**[112.46] (D); How do you assess water quality for postharvest uses? Testing? How frequently and when? What test(s) [target organism, testing method] are you using? Do you know what your water unit testing is? How do you take your water samples? Are you familiar with the Microbial Water Quality standards required for postharvest water?

[112.48(a)]; Do you re-use or recirculate water? If so, please describe.
How do you determine when it's time to change recirculated water?

**[112.43] (D); Do you use an antimicrobial (sanitizer, uV)? How do you use them? How do you monitor their effectiveness? How frequently do you monitor it?
(Depending on your sanitizer) Do you monitor the pH of this water?

[112.48(b)]; Are you familiar with water turbidity? How do you gauge/measure this?
[112.48(c)]; Based on what you harvest, is the temperature of the water a concern? How do you address it?

**[112.45] (D); What do you do if a water test comes back higher than expected (a positive generic *E. coli* test)? How would you correct this in your packinghouse?

*112.50(a) (D); What documents do you keep related to you water sources, antimicrobial use, and testing?

DOMESTIC & EXPORT STATISTICS

CALIFORNIA'S TOP 5 STATES
CALIFORNIA DOMESTIC BLUEBERRY STATISTICS
CALIFORNIA'S TOP 5 EXPORT MARKETS
CALIFORNIA EXPORT TOTALS

CALIFORNIA'S TOP 5 STATES

2012 - 2013		
1	CALIFORNIA	14,015,701.65
2	TEXAS	2,706,376.00
3	ILLINOIS	2,541,217.38
4	WASHINGTON	2,393,252.60
5	ARIZONA	1,861,313.65

2015 - 2016		
1	CALIFORNIA	16,157,728.85
2	TEXAS	3,101,171.30
3	OREGON	2,862,584.90
4	WASHINGTON	2,396,763.00
5	ARIZONA	1,766,860.90

2013 - 2014		
1	CALIFORNIA	17,207,854.75
2	TEXAS	3,725,549.65
3	WASHINGTON	3,058,290.00
4	ILLINOIS	2,187,860.40
5	ARIZONA	1,969,871.30

2016 - 2017		
1	CALIFORNIA	17,429,809.80
2	WASHINGTON	5,042,722.20
3	TEXAS	3,518,891.50
4	OREGON	2,400,281.95
5	ILLINOIS	1,841,706.40

2014 - 2015		
1	CALIFORNIA	17,280,464.95
2	WASHINGTON	3,554,432.05
3	TEXAS	3,088,911.55
4	ILLINOIS	2,407,563.70
5	OREGON	2,379,966.50

2017-2018		
1	CALIFORNIA	22,894,971.73
2	WASHINGTON	4,300,988.40
3	OREGON	3,136,641.12
4	TEXAS	2,619,940.40
5	ILLINOIS	1,581,698.40

2017 - 2018 DOMESTIC

ALABAMA	100,484.00	NEBRASKA	49,814.00
ALASKA	21,800.00	NEVADA	349,636.80
ARIZONA	1,709,576.50	NEW HAMPSHIRE	59,817.60
ARKANSAS	129,730.00	NEW JERSEY	333,043.20
CALIFORNIA	17,429,809.80	NEW MEXICO	83,496.00
COLORADO	697,196.40	NEW YORK	1,320,075.50
CONNECTICUT	629,009.40	NORTH CAROLINA	250,377.50
FLORIDA	558,777.80	NORTH DAKOTA	2,889.00
GEORGIA	219,939.30	OHIO	456,071.50
HAWAII	234,932.40	OKLAHOMA	410,940.40
IDAHO	172,092.60	OREGON	2,400,282.95
ILLINOIS	1,841,706.40	PENNSYLVANIA	1,507,938.00
INDIANA	632,333.80	RHODE ISLAND	226.00
IOWA	236,156.00	SOUTH CAROLINA	27,623.00
KANSAS	68,379.00	SOUTH DAKOTA	47.00
KENTUCKY	78,281.80	TENNESSEE	18,144.00
LOUISIANA	90,286.00	TEXAS	3,518,891.50
MAINE	138,843.00	UTAH	1,237,397.25
MARYLAND	635,527.80	VERMONT	13,521.60
MASSACHUSETTS	643,023.65	VIRGINIA	28,898.00
MICHIGAN	936,743.92	WASHINGTON	5,042,722.20
MINNESOTA	842,544.80	WEST VIRGINIA	410.00
MISSISSIPPI	29,273.00	WISCONSIN	638,901.40
MISSOURI	526,995.00	WYOMING	128,744.00
MONTANA	7,595.00	UNKNOWN	4,439,269.00
		TOTAL POUNDS	**50,931,104.97**

2016 - 2017 DOMESTIC

ALABAMA	100,484.00	NEBRASKA	49,814.00
ALASKA	21,800.00	NEVADA	349,636.80
ARIZONA	1,709,576.50	NEW HAMPSHIRE	59,817.60
ARKANSAS	129,730.00	NEW JERSEY	333,043.20
CALIFORNIA	17,429,809.80	NEW MEXICO	83,496.00
COLORADO	697,196.40	NEW YORK	1,320,075.50
CONNECTICUT	629,009.40	NORTH CAROLINA	250,377.50
FLORIDA	558,777.80	NORTH DAKOTA	2,889.00
GEORGIA	219,939.30	OHIO	456,071.50
HAWAII	234,932.40	OKLAHOMA	410,940.40
IDAHO	172,092.60	OREGON	2,400,282.95
ILLINOIS	1,841,706.40	PENNSYLVANIA	1,507,938.00
INDIANA	632,333.80	RHODE ISLAND	226.00
IOWA	236,156.00	SOUTH CAROLINA	27,623.00
KANSAS	68,379.00	SOUTH DAKOTA	47.00
KENTUCKY	78,281.80	TENNESSEE	18,144.00
LOUISIANA	90,286.00	TEXAS	3,518,891.50
MAINE	138,843.00	UTAH	1,237,397.25
MARYLAND	635,527.80	VERMONT	13,521.60
MASSACHUSETTS	643,023.65	VIRGINIA	28,898.00
MICHIGAN	936,743.92	WASHINGTON	5,042,722.20
MINNESOTA	842,544.80	WEST VIRGINIA	410.00
MISSISSIPPI	29,273.00	WISCONSIN	638,901.40
MISSOURI	526,995.00	WYOMING	128,744.00
MONTANA	7,595.00	UNKNOWN	4,439,269.00
		TOTAL POUNDS	**50,931,104.97**

2015 - 2016 DOMESTIC

ALABAMA	52,950.20	NEBRASKA	112,167.60
ALASKA	47,919.20	NEVADA	477,141.60
ARIZONA	1,766,860.90	NEW HAMPSHIRE	93,745.90
ARKANSAS	117,710.40	NEW JERSEY	837,352.45
CALIFORNIA	16,157,728.85	NEW MEXICO	186,350.80
COLORADO	717,984.50	NEW YORK	1,523,512.40
CONNECTICUT	379,290.60	NORTH CAROLINA	127,539.60
FLORIDA	477,006.70	NORTH DAKOTA	13,849.10
GEORGIA	159,211.40	OHIO	803,168.90
HAWAII	227,027.90	OKLAHOMA	397,582.60
IDAHO	96,134.40	OREGON	2,862,584.90
ILLINOIS	1,347,000.50	PENNSYLVANIA	1,112,086.45
INDIANA	576,671.70	RHODE ISLAND	6,970.20
IOWA	243,302.25	SOUTH CAROLINA	48,158.60
KANSAS	132,761.20	TENNESSEE	117,469.20
KENTUCKY	92,550.30	TEXAS	3,101,171.30
LOUISIANA	106,935.00	UTAH	1,428,975.30
MAINE	61,254.40	VERMONT	29,925.60
MARYLAND	440,326.20	VIRGINIA	109,501.90
MASSACHUSETTS	518,754.80	WASHINGTON	2,396,763.00
MICHIGAN	418,767.60	WEST VIRGINIA	577.20
MINNESOTA	1,450,716.20	WISCONSIN	477,079.00
MISSISSIPPI	73,591.70	WYOMING	402,398.80
MISSOURI	521,097.40		
MONTANA	6,658.00	*UNKNOWN	3,637,122.00
		TOTAL POUNDS	**46,493,406.70**

2014 - 2015 DOMESTIC

ALABAMA	35,500.30		NEBRASKA	274,875.60
ALASKA	83,817.10		NEVADA	334,084.30
ARIZONA	2,060,648.05		NEW HAMPSHIRE	36,481.00
ARKANSAS	181,310.20		NEW JERSEY	480,078.40
CALIFORNIA	17,280,464.95		NEW MEXICO	178,928.50
COLORADO	796,866.80		NEW YORK	1,212,796.00
CONNECTICUT	505,881.90		NORTH CAROLINA	80,758.10
FLORIDA	308,779.90		NORTH DAKOTA	10224.70
GEORGIA	135,765.90		OHIO	559,042.00
HAWAII	91,984.20		OKLAHOMA	703,083.40
IDAHO	372,305.40		OREGON	2,379,966.50
ILLINOIS	2,407,563.70		PENNSYLVANIA	691,835.40
INDIANA	889,127.90		RHODE ISLAND	744.50
IOWA	422,725.00		SOUTH CAROLINA	24,960.90
KANSAS	177,392.50		SOUTH DAKOTA	122.10
KENTUCKY	102,239.60		TENNESSEE	18,505.60
LOUISIANA	219,972.70		TEXAS	3,088,911.55
MAINE	2,420.50		UTAH	1,555,797.20
MARYLAND	1,017,245.55		VERMONT	9,270.00
MASSACHUSETTS	609,730.10		VIRGINIA	410,201.30
MICHIGAN	456,347.90		WASHINGTON	3,554,432.05
MINNESOTA	745,043.40		WEST VIRGINIA	501.00
MISSISSIPPI	66,573.00		WISCONSIN	755,216.40
MISSOURI	866,498.30		WYOMING	452,285.00
MONTANA	11,864.80		WYOMING	452,285.00
			UNKNOWN	2,083,264*
			TOTAL POUNDS	48,744,435.15

2013 - 2014 DOMESTIC

ALABAMA	28,307.60	NEBRASKA	209,258.10
ALASKA	56,363.00	NEVADA	368,364.50
ARIZONA	1,969,871.30	NEW HAMPSHIRE	9,823.20
ARKANSAS	110,632.70	NEW JERSEY	241,845.20
CALIFORNIA	17,207,854.75	NEW MEXICO	17,251.40
COLORADO	922,866.45	NEW YORK	987,295.90
CONNECTICUT	546,817.00	NORTH CAROLINA	76,999.80
DISTRICT OF COLUMBIA	1,128.00	NORTH DAKOTA	540.50
FLORIDA	727,266.60	OHIO	362,442.00
GEORGIA	196,330.10	OKLAHOMA	658,426.10
HAWAII	324,449.20	OREGON	1,810,950.40
IDAHO	45,798.80	PENNSYLVANIA	878,854.50
ILLINOIS	2,187,860.40	RHODE ISLAND	1,059.80
INDIANA	670,770.70	SOUTH CAROLINA	66,433.40
IOWA	295,114.30	SOUTH DAKOTA	98.70
KANSAS	86,957.50	TENNESSEE	335,267.20
KENTUCKY	70,505.70	UTAH	1,305,574.60
LOUISIANA	264,058.80	VERMONT	55,681.00
MAINE	10,392.00	VIRGINIA	162,435.20
MARYLAND	368,814.35	WASHINGTON	3,058,290.00
MASSACHUSETTS	401,470.80	WEST VIRGINIA	1,035.90
MICHIGAN	372,039.00	WISCONSIN	861,811.50
MINNESOTA	491,802.70	WYOMING	541,252.00
MISSISSIPPI	52,355.90	UNKNOWN	2,183,262.30
MISSOURI	878,638.80	**TOTAL POUNDS**	**46,215,990.30**

2012 - 2013 DOMESTIC

ALABAMA	53,445.70		NEVADA	304,433.40
ALASKA	23,273.00		NEW HAMPSHIRE	4,886.40
ARIZONA	1,861,313.65		NEW JERSEY	430,021.80
ARKANSAS	80,388.30		NEW MEXICO	245,988.30
CALIFORNIA	14,015,701.65		NEW YORK	1,138,433.00
COLORADO	902,074.40		NORTH CAROLINA	170,207.10
CONNECTICUT	813,857.40		OHIO	522,836.50
DISTRICT OF COLUMBIA	658.00		OKLAHOMA	477,312.20
FLORIDA	782,067.90		OREGON	1,030,171.10
GEORGIA	201,274.30		PENNSYLVANIA	656,664.60
HAWAII	357,509.20		RHODE ISLAND	3,819.50
IDAHO	147,634.80		SOUTH CAROLINA	34,049.60
ILLINOIS	2,541,217.38		SOUTH DAKOTA	582.80
INDIANA	805,074.30		TENNESSEE	66,528.30
IOWA	416,965.30		TEXAS	2,706,376.00
KANSAS	171,367.20		UTAH	1,320,551.80
KENTUCKY	63,654.60		VERMONT	66,848.00
LOUISIANA	220,323.40		VIRGINIA	41,650.10
MAINE	12,465.00		WASHINGTON	2,393,252.60
MARYLAND	721,384.90		WEST VIRGINIA	271.40
MASSACHUSETTS	603,010.00		WISCONSIN	605,958.20
MICHIGAN	612,485.90		WYOMING	381,982.00
MINNESOTA	481,953.10		UNKNOWN	1,885,449*
MISSISSIPPI	112,459.30			
MISSOURI	1,027,812.00			
MONTANA	9,373.00			
NEBRASKA	226,073.40		**TOTAL POUNDS**	**38,457,320.78**

CALIFORNIA'S TOP 5 EXPORT MARKETS

	2012 - 2013	
1	CANADA	5,406,857.85
2	HONG KONG	766,383.40
3	JAPAN	503,181.30
4	TAIWAN	342,840.90
5	UNITED ARAB EMIRATES	95,581.90

	2015 - 2016	
1	CANADA	5,535,926.60
2	JAPAN	620,502.60
3	HONG KONG	497,684.80
4	TAIWAN	472,077.50
5	UNITED KINGDOM	407,222.40

	2013 - 2014	
1	CANADA	5,561,045.56
2	HONG KONG	869,299.40
3	SINGAPORE	625,528.00
4	JAPAN	490,001.00
5	TAIWAN	155,957.40

	2016 - 2017	
1	CANADA	4,344,354.30
2	TAIWAN	601,398.40
3	JAPAN	484,568.40
4	UNITED KINGDOM	413,942.40
5	HONG KONG	184,406.40

	2014 - 2015	
1	CANADA	6,756,681.00
2	HONG KONG	625,810.40
3	TAIWAN	444,074.30
4	JAPAN	440,469.40
5	SINGAPORE	238,893.10

	2017 - 2018	
1	CANADA	4,419,874,15
2	TAIWAN	514,072.00
3	JAPAN	385,936.70
4	DUBAI	133,225.80
5	HONG KONG	130,053.00

2017 - 2018 EXPORT

BAHRAIN	33,206.80	MYANMAR	2790.00
BANGKOK	0	OMAN	3,496.50
BRAZIL	12,292.00	PANAMA	1,291.50
CAMBODIA	85,860.00	PHILIPPINES	258,196.50
CANADA	3,265,651.00	PUERTO RICO	1,615.50
FRENCH POLYNESIA	118,020.00	QATAR	24,736.50
GUAM	633,438.00	SAUDI ARABIA	238,182.90
HONG KONG	46,309.10	SINGAPORE	399,019.50
ICELAND	7,914.00	TAIWAN	65,981.10
INDIA	73,617.60	THAILAND	132,223.20
INDONESIA	5,616.00	UNITED ARAB EMIRATES	191,312.00
JAPAN	374,907.90	UNITED KINGDOM	25,452.60
KOREA	3,852.00	URAGUAY	983.10
KUWAIT	342.642.00		
MALAYSIA	113,940.00		
MEXICO	25,061.00	**TOTAL POUNDS**	
			6,479,694.30

2016 - 2017 EXPORT

BAHRAIN	4,119.00	MYANMAR	420.00
BANGKOK	5,702.40	NETHERLANDS	5.00
BRAZIL	2,840.00	NEW ZELAND	17,424.00
CAMBODIA	700.00	OMAN	3,801.00
CANADA	4,344,354.30	PHILIPPINES	6,558.00
FRENCH POLYNESIA	10,469.00	PUERTO RICO	210.00
GUAM	3,233.00	QATAR	24,559.00
HONG KONG	201,513.60	SAUDI ARABIA	67,834.00
INDIA	634.00	SINGAPORE	79,079.50
INDONESIA	12,618.00	TAIWAN	601,398.40
JAPAN	484,568.40	THAILAND	24,512.00
KOREA	611.00	UNITED ARAB EMIRATES	108,061.60
KUWAIT	53,694.00	UNITED KINGDOM	413,942.40
MALAYSIA	5,329.20	URAGUAY	634.00
MEXICO	715.00		
		TOTAL POUNDS	**6,479,539.80**

2015 - 2016 EXPORT

BAHRAIN	5,011.90		MYANMAR	3,168.00
BELGIUM	24,235.00		NEW ZEALAND	108,667.20
BRAZIL	21,591.90		NORTHERN MARIANA ISLANDS	70.00
CAMBODIA	5.00		OMAN	3311.00
CANADA	5,535,926.60		PANAMA	144.00
FRENCH POLYNESIA	8,087.40		PHILIPPINES	8007.60
GERMANY	8,078.00		PUERTO RICO	564.00
GUAM	1,619.60		QATAR	29,556.90
HONG KONG	497,684.80		SAUDI ARABIA	70,601.90
INDONESIA	12,461.80		S. KOREA	3,240.10
IRELAND	25,920.00		SINGAPORE	130,309.50
JAPAN	620,502.60		TAIWAN	472,077.50
KAZAKHSTAN	338.40		THAILAND	41,589.60
KUWAIT	76,245.30		UNITED ARAB EMIRATES	77,799.80
MALAYSIA	25,827.40		UNITED KINGDOM	407,222.40
MEXICO	15,424.40		VIETNAM	20013.50
			TOTAL POUNDS	**8,255,303.10**

2014 - 2015 EXPORT

BAHRAIN	3,219.00	NETHERLANDS	9.40
BRAZIL	27,015.00	NEW ZEALAND	137,870.40
CANADA	6,756,681.00	NORTHERN MARIANA ISLANDS	1341.50
EL SALVADOR	634.00	OMAN	2,620.00
FRENCH POLYNESIA	10,662.80	PANAMA	229.80
GUAM	2,053.60	PHILIPPINES	235.00
HONG KONG	625,810.40	PUERTO RICO	3,139.60
INDIA	4,357.30	QATAR	16,630.60
INDONESIA	8,298.70	SAUDI ARABIA	50,477.00
IRAQ	575.50	SINGAPORE	238,893.10
JAPAN	440,469.40	TAIWAN	444,074.30
KAZAKHSTAN	2,199.60	THAILAND	41,568.40
KOREA	9,624.30	UNITED ARAB EMIRATES	82,486.40
KUWAIT	42,383.60	UNITED KINGDOM	40,499.00
MALAYSIA	46,000.20	URUGUAY	1,287.00
MALDIVES	35.00	VIETNAM	7647.70
MEXICO	3,098.30		
		TOTAL POUNDS	**9,052,126.90**

2013 - 2014 EXPORT

BAHRAIN	3,611.40	NORTHERN MARIANA ISLANDS	428.50
BRAZIL	22,091.00	OMAN	2,550.20
CANADA	5,561,045.56	PANAMA	175.00
CAMBODIA	1,099.00	PHILIPPINES	9,605.20
FRENCH POLYNESIA	5,905.00	PUERTO RICO	5422.1
GUAM	2,096.30	QATAR	8,918.20
HONG KONG	869,299.40	RUSSIA	11,412.40
IRAQ	1,128.00	SAUDI ARABIA	32,258.60
JAPAN	490,001.00	SCOTLAND	34,146.00
KAZAKHSTAN	592.20	SINGAPORE	625,528.00
SOUTH KOREA	10,061.40	TAIWAN	155,957.40
KUWAIT	30,809.70	THAILAND	25,989.40
MALAYSIA	38,216.60	UNITED ARAB EMIRATES	72,185.60
MALDIVES	182.20	UNITED KINGDOM	44,136.00
MEXICO	39,315.80	UNKNOWN	6,013.00
NEW ZEALAND	142,877.00		
		TOTAL POUNDS	**8,253,057.16**

**Unknown due to destinations being incomplete at time of press.*

2012 - 2013 EXPORT

BAHRAIN	2,590.00		NEW ZEALAND	6,336.00
BRAZIL	20,511.00		NORTHERN MARIANA ISLANDS	65.8
CANADA	5,406,857.85		OMAN	893.4
COSTA RICA	792.00		PANAMA	601.5
DUBAI	3,780.00		PHILIPPINES	6,695.20
FRENCH POLYNESIA	2,440.80		PUERTO RICO	4,058.20
GUAM	1,205.80		QATAR	6,799.50
HONG KONG	766,385.40		RUSSIA	6,152.30
INDONESIA	10,976.90		SAUDI ARABIA	14,015.70
JAPAN	503,181.30		SCOTLAND	39,312.00
KAZAKHSTAN	1,193.80		SINGAPORE	78,361.10
KOREA	10,095.90		TAIWAN	342,840.90
KUWAIT	29,452.40		THAILAND	12,434.90
LEBANON	42.00		UNITED ARAB EMIRATES	95,581.90
MALAYSIA	24,929.80		UNITED KINGDOM	25,920.00
MALDIVES	45.5		VIETNAM	3,213.50
MEXICO	25,030.00			
			TOTAL POUNDS	**7,452,792.35**

INDUSTRY COMMUNICATIONS

COMMUNICATIONS OVERVIEW

The California Blueberry Commission takes pride in ensuring our audience is kept up to date with issues concerning the blueberry industry. The CBC is on social media. Please follow us on the following social media outlets, and let us know what you think. We would love to know what you want to hear more about.

Facebook.com/CaliforniaBlueberryCommission

Pinterest.com/calblueberry

The CBC has published a series of newsletters throughout the season, and they are included in this year's annual report. The CBC encourages you to sign up for our newsletters that are available both online and in hard copy. To sign up for the CBC online newsletter, visit Calblueberry.org under the "About Us" tab. You can subscribe in the newsletter section. To subscribe to our hard copy newsletter please contact the CBC office. The CBC sends out newsletters on a bi-monthly basis.

CALIFORNIA Blueberry COMMISSION

NEWSLETTER

Issue No. 17 January/February 2018

BOARD OF DIRECTORS

eDisclosure for e-Filing FORM 700

As outlined by CDFA and the Fair Political Practices Commission (FPPC) all Board of Directors filers must complete the necessary Form 700. Board members are now eligible to submit your Form 700 electronically through eDisclosure. To access the eDisclosure system and complete your e-filing Form 700, please log on to **https://form700.fppc.ca.gov/**. Upon login you will see a list of positions that you are required to file Form 700's for. Once completed, your Form will be saved in your online-filing cabinet under "Previous Filings" menu.

As a reminder the Form 700 is due April 2, 2018.

Should you have any problems accessing or completing your eDisclosure Form 700, please contact Rene Robertson at (916) 324-3722 or via email at Form700@fppc.ca.gov .

COMMISSION ATTENDS FRUIT LOGISTICA

On February 7-9, 2018, the California Blueberry Commission participated in Fruit Logistica, Berlin, Germany. Fruit Logistica is the largest fresh fruit trade show in the world, it covers the fresh produce business and offers a complete picture of the latest innovations, products, and services in the international supply chain. This trade show provides the Commission the unique opportunity to reach a vast audience of retailers and importers from around the world. If you would like more information, please contact the Commission office.

CBC WELCOMES NEW INTERN

In December 2017, the CBC welcomed aboard a new intern, Emily Baker. Emily is a junior at California State University, Fresno where she is pursuing a Bachelor's Degree in Agriculture Business. Emily is from Merced, California and currently resides in Fresno, California. Her hobbies include crafting, redoing furniture, her dogs, traveling, and much more all while spending time with her family and friends. Emily has a passion for agriculture and is extremely excited to experience all the aspects of agriculture that the Commission has to offer. She looks forward to the valuable knowledge that she will gain through this internship experience.

USDA SECRETARY ROLLED OUT FARM BILL & LEGISLATIVE PRINCIPLES

During the week of January 24, 2018, U.S. Secretary of Agriculture Sonny Perdue, was at Pennsylvania State University touring facilities and meeting with faculty and students. The secretary toured Reinford Farms in Mifflintown, PA. and attended a luncheon town hall meeting where he rolled out the U.S. Department of Agriculture's Farm Bill and legislative principles for 2018. The principles were outlined in a four-page document, which states its goal as "to be responsive to the American people and improve services while reducing regulatory burdens on USDA customers." In addition, Secretary Perdue toured Central Pennsylvania's Food Bank in Harrisburg, and held a roundtable discussion on nutrition assistance

CBC PARTNERS WITH CALIFORNIA CHERRY BOARD FOR PROMOTIONS IN JAPAN

The CBC has partnered with the California Cherry Board (CCB) for promotions in Japan. BCI will contact growers for more information on specifics. The grant purpose is to bring the promotion of fresh blueberries and cherries to markets in Japan. Japan has shifted to purchasing lower quality fruits to meet price requirements. CBC and CCB are looking to bring the reputation of California fresh fruit back to the markets of Japan. This will increase the demand and export volumes of these commodities by organizing large scale, collaborative promotions directly with Japanese retail outlets. Leveraging the California Grown identity, CCB and CBC will highlight the availability of California cherries and blueberries as the first fresh imported fruit of the summer.

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CALENDAR OF EVENTS

- Canadian Produce Marketing Association (CPMA) Convention & Trade Show

  -Date: April 24-26, 2018

  -Vancouver, BC, Canada

- United FreshMKT Expo

  -Date: June 25-27, 2018

  -Chicago, Illinois

- United Fresh Public Policy Conference

  -Date: September 24-26, 2018

  -Washington, D.C.

- Produce Marketing Association (PMA)

  -Date: October 18-20, 2018

  -Orlando, Florida

CALIFORNIA Blueberry COMMISSION

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BLUEBERRY BITES

Classic Blueberry Pie

Ingredients:

- 4 rounded cups Fresh Ca Blueberries
- ½ tsp grated lemon peel
- 2 ½ tbsp. cornstarch
- 1 tbsp. butter
- 1 refrigerated pie crust

Directions:

1. Roll out one sheet pie crust to flatten. Fit into a 9-inch pie dish.
2. In a medium saucepan combine 1 cup of the blueberries, sugar, cornstarch and 2 tablespoons water. Bring to a boil; cook and stir until mixture is thickened and clear. Stir in butter; cool for 5 minutes. Stir in the remaining 3 cups blueberries and lemon peel.
3. Preheat oven to 400 degrees. Turn cooled filling into pie shell. Lay the remaining pie crust on a sheet of wax paper. Roll out to flatten. With a knife or pastry wheel cut pastry into 3/8-inch wide strips. Arrange in a crisscross pattern on top of blueberries, pressing ends into the edges of the bottom crust and crimping to seal.
4. Place pie on a baking sheet. Bake in the bottom third of oven until crust is golden and filling bubbles gently, about 30 minutes. Cool on rack.

Recipe courtesy of U.S. Highbush Blueberry Council

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CALIFORNIA Blueberry COMMISSION

Newsletter

Issue No. 19 March/April 2018

COMMISSION ATTENDS CAPITOL HILL DAY

During the week of March 13-15, 2018, the California Blueberry Commission met with key Congressional leadership and other agencies in Washington D.C. The meetings were designed to inform and educate the different partners and leaders regarding the significant issues that California's agriculture, specifically blueberries will face in the near future. One of the issues discussed, was the upcoming 2018 Farm Bill that Congress is now currently writing. For more information, please contact the Commission office.

CONCERNS OF FREEZE ON EARLY BLUEBERRIES

California's blueberry crop has suffered damage from the recent cold temperatures throughout California. Some freeze damage that has occurred, but the extent of damage is still being examined. For the next several weeks, the Commission is participating in conference calls to discuss the crop forecast and evaluate which varieties were affected the most.

For more information regarding the freeze, please contact the Commission office.

DISCUSSIONS BEGIN ON 2018 FARM BILL

The U.S. Farm Bill is a comprehensive piece of legislation that Congress is currently writing. It covers most federal government policies related to agriculture in the United States. The Farm Bill comes up for renewal every five years. Many individuals and organizations contribute to the Farm Bill, including members of government and special interest groups. The provisions of the Farm Bill are divided into what are called "Titles", which are overarching categories related to food and farming in the U.S. The 2014 Farm Bill had 12 titles, and new titles can be added during the re-authorization process. Several things to note, if included in the 2018 Farm Bill, will be the re-examination of crop insurance, and a trade policy revamp.

CONGRESS REACHES DEAL ON SPENDING BILL

Congressional leaders finalized a $1.3 trillion budget bill that will keep the federal government open through the remainder of the current fiscal year, ending September 30, 2018. This is good news because a government shutdown is unlikely to happen, preventing disruption to programs including H-2A processing. It also means important programs such as specialty crop research, Market Access Program (MAP), and crop insurance will continue to be funded. The deal is reported to include $1.6 billion in funds for border security, but does not include funds for a wall, mandate E-Verify or include guestworker or DACA provisions. For apple growers who belong to co-ops, this should result in a status quo as regards to their bottom lines and deductions. For more information, please contact the Commission office.

CHINA TARGETS U.S. AGRICULTURE IN IMPOSING NEW TARIFFS

China is imposing new tariffs on meat, fruit, and other products from the United States as retaliation against tariffs approved by President Trump on imported steel and aluminum. The announcement follows warnings Chinese officials have made for several weeks in an escalating trade dispute, between the world's two largest economies. China's Customs Tariff Commission is increasing the tariff rate and imposing a new 15 percent tariff on 120 other imported U.S. commodities, including almonds, apples and berries which could end up hurting the American farmers. The Commission will be following closely and will continue to update the industry as needed.

NABC AND USHBC SPRING MEETING IN UTAH

The North American Blueberry Council and the United States Highbush Blueberry Council conducted their spring meeting on February 28 through March 2, 2018, in Salt Lake City, Utah. The NABC and the USHBC held meetings for their respective committees, discussing current topics and updates. Industry members from around the country had the chance to meet and discuss the blueberry industry at the semiannual meeting. The NABC and USHBC next Fall 2018 Meeting will be held in New Orleans, Louisiana. For more information please visit (http://www.blueberry.org/) or contact the Commission office.

COMMISSION MEETS WITH UNDERSECRETARY MCKINNEY

On April 24, 2018, the Commission met with USDA Undersecretary for Trade and Foreign Agricultural Affairs Ted McKinney, and the California State Board of Food and Agriculture President Don Cameron. The purpose of the meeting was to discuss the importance of international trade markets to California agriculture. Specifically, the discussions focused on the new tariffs implemented by China, the India market, the constant changing MRLs for export markets, including the EU, and the North American Free Trade Agreement (NAFTA). Currently, California exports approximately 12 - 18 percent of its blueberry crop. However, export issues that directly impact other states will have an indirect effect on California blueberries. If blueberries are not exported, those fresh or processed berries may stay in the domestic market, driving down prices when increasing supply. It is important to ensure that these markets remain open and competitive in order to ensure that both international and domestic markets remain healthy. The Commission will continue to communicate the importance of free and fair trade with the administration and update the industry as these issues continue to move forward.

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Blueberry Bites

Blueberry Walnut Salad

Ingredients:

- 1 (10 oz.) package mixed salad greens
- 1 Pint fresh California blueberries
- 1 ¼ C Walnuts
- ½ C Raspberry Vinaigrette dressing
- ¼ C Feta Cheese Crumbles

Directions:

1. In a large bowl, mix together salad greens with fresh CA blueberries, walnuts, and raspberry vinaigrette. Top with feta cheese to serve and enjoy!

Recipe courtesy of allrecipes.com

CALENDAR OF EVENTS

- **United FreshMKT Expo**

  -Date: June 25-27, 2018

  -Chicago, Illinois

- **Asia Fruit Logistica**

  -Date: September 4-7, 2018

- **United Fresh Public Policy Conference**

  -Date: September 24-26, 2018

  -Washington, D.C.

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CALIFORNIA Blueberry COMMISSION

Newsletter

Issue No. 19 May/June 2018

CBC ALEXANDER J. OTT NAMED EXECUTIVE DIRECTOR OF THE AMERICAN PECAN COUNCIL

The California Blueberry Commission's Alexander J. Ott is the new Executive Director of the American Pecan Council. He will begin his position July 1, 2018. He served as Executive Director for the California Blueberry Commission since 2010, and in addition, the California Apple Commission for the past 13 years. Alex will relocate from California to Texas to lead the American Pecan Council. We are honored and grateful for the outstanding leadership and service as Executive Director to the California Blueberry Commission and wish Alexander all the best in his future venture.

CALIFORNIA BLUEBERRY ASSESSMENTS, DESTINATION REPORTS AND GROWER PRODUCTION

Assessments & Destinations: Handlers who pack blueberries must submit their completed assessment report(s) along with the assessment payment and attached destinations by August 10, 2018. Failure to submit reports or pay assessments may result in penalties and legal action.

Grower Production: Please mail in complete grower production information by August 31, 2018. According to state law, this information is needed to properly assist in the Commission duties. Penalties may be administered should this information not be provided. Should you have any questions please contact the Commission office.

HOUSE OT VOTE ON TWO IMMIGRATION BILLS

Speaker of the House, Paul Ryan (R-WI), announced in June, that the House of Representatives will vote next week on two bills, one addressing border security and immigration reform measure and the other addressing Deferred Action for Childhood Arrivals (DACA). Conservatives have been clear that any deal must mandate that all employers verify the legal status of employees, known as E-Verify. Moderates sternly communicated that any discussion of E-Verify must also include a guest worker program. For more information, please contact your districts congressman or the Commission office.

MEXICO TO IMPOSE TARIFFS ON FRESH & DRIED FRUIT

The Mexican government has said it will impose retaliatory tariffs on U.S. goods, including blueberries and other produce items, in response to the Trump Administration announcing it would impose tariffs on steel and aluminum from Canada, Mexico, and the European Union effective June 1. The tariff was applied on steel and aluminum imports because overcapacity in those industries globally is thought to be hurting US steel mills and aluminum smelters by driving down the prices of their product, forcing many out of business. NAFTA, generally prevents the US, Mexico, and Canada from imposing tariffs on imports from one another, but President Trump has been a severe critic of NAFTA, and the three countries are holding negotiations on possible changes to the free trade deal. The CBC and USHBC has been in contact with Administration officials as well as with our trade contacts at the Mexican and Canadian embassies.

SENATE AG COMMITTEE PASSES FARM BILL

In June, the Senate Agriculture Committee marked up and passed the Agriculture Improvement Act of 2018, by a vote of 20-1. Many provisions are important to our industry. These include:

- Full funding for trade programs such as the Market Access Program (MAP) and the Technical Assistance for Specialty Crops Program (TASC);
- $80 million in funding for all specialty crops under the Specialty Crop Research Initiative (SCRI) and new prioritization for mechanization projects;
- Full $85 million in funding for the Specialty Crop Block Grant Program (SCBGP) with $5 million set aside for multi-state programs to be administered through the Agricultural Marketing Service (AMS).

TODD SANDERS NAMED EXECUTIVE DIRECTOR OF THE CBC

Todd Sanders has been named Executive Director of the California Blueberry Commission. His selection was approved by the CAC apple Board of Directors at the May 3, 2018, meeting. He replaces Alexander Ott, who has accepted a new position with the American Pecan Council and will relocate from California to Texas to lead the APC. Prior to be chosen Executive Director of the CBC, Mr. Sanders, served as the

Director of Trade and Technical Affairs for the California Apple Commission since 2005. In addition, Mr. Sanders will also serve as Executive Director to the California Apple Commission and the California Olive Committee. He graduated from California State University, Fullerton with a B.A. degree in Psychology and a Master's Degree in International Relations from California State University, Fresno.

ELIZABETH CARRANZA TO BE NAMED DIRECTOR OF TRADE AND TECHNICAL AFFAIRS OF THE CBC

On July 1, the California Blueberry Commission will welcome a new Director of Trade and Technical Affairs, Elizabeth Carranza. Elizabeth was a former intern of the CAC and graduated from California State University, Fresno with a degree in Agricultural Business. Upon graduation, Elizabeth went on to serve as a Congressional intern in Washington, DC and then returned to California to hold the position of Program Supervisor for the California Olive Committee. Throughout the past two years in this role, Elizabeth worked under the direct supervision of Todd Sanders in overseeing the California Olive Committee's newly established international export programs. Currently, and with the onset of this new position, Elizabeth is pursuing a higher education in the form of a Master's Degree in Communication Management online from the University of Southern California to be completed in 2019.

Blueberry Bites

5 INGREDIENT WATERMELON BLUEBERRY SALAD

Ingredients:

- 1 Med. seedless watermelon
- 1 ½ C fresh California Blueberries
- 1 lime juiced – ¼ C
- 4 Mint leaves - shredded
- ½ C Feta Cheese

Directions:

1. Slice Watermelon and using a small star cookie cutter cut into shapes and place in large mixing bowl.
2. Add blueberries, mint leaves, feta cheese, and lime juice.
3. Toss gently.
4. Serve immediately or store covered in fridge until ready to serve.
5. Servings: 10 people.

Recipe courtesy of www.stephaniesain.com.

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CALENDAR OF EVENTS

- United FreshMKT Expo

  -Date: June 25-27, 2018

  -Chicago, Illinois

- Asia Fruit Logistica

  -Date: September 4-7, 2018

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CALIFORNIA Blueberry COMMISSION

Newsletter

Issue No. 21 July/August 2018

COMMISSION MEETS WITH U.S. AG. SECRETARY, SONNY PERDUE

On August 14, 2018, the California Blueberry Commission met with U.S. Agriculture Secretary Sonny Perdue, along with local growers and producers in Modesto, Calif., at a town hall meeting to learn about critical agriculture issues facing Central Valley farmers. The topic of discussions included, water, trade barriers and upcoming tariffs.

ASIA FRUIT LOGISTICA

On September 5-7, 2018, the California Blueberry Commission (CBC) will travel to Hong Kong for Asia Fruit Logistica. This is the largest fresh fruit trade show in Asia and provides the Commission the opportunity to reach a vast audience and allows visitors to get direct contact with exhibitors. The Asia Fruit Logistica is Asia's leading trade show for the international fresh fruit and vegetable business. In addition, the California Blueberry Commission will participate in a partnership, with the California Olive Committee to host a booth in the U.S. Pavilion. This will provide the CBC with the opportunity to create awareness of California blueberries in various Asian markets, in addition to, establishing relationships with key market contacts. For more information, please contact the Commission office.

US & MEXICO REACH NEW TRADE AGREEMENT

The United States and Mexico reached an agreement to enter a new trade deal, replacing the former North American Free Trade Agreement (NAFTA). The new trade pact will be called "The United States - Mexico Trade Agreement," according to President Trump. Mexico President Nieto stated that "This is something very positive for the United States and Mexico," and, has agreed to immediately begin purchasing as many agricultural products from the United States as possible. For more information, please contact the Commission office.

NEW BOARD SET FOR 2018-2019

Congratulations to the California Blueberry Commission's Board of Directors for FY 2018-2019!

DISTRICT ONE	
Member	Alternate
Vacant	Will Gerry
DISTRICT TWO	
Member	Alternate
Dennis Burreson	Stan Kaufman
DISTRICT THREE	
Member	Alternate
Tobin Martin	Young Kwun
First Statewide Position	
Member	Alternate
Jon Marthedal	Scott Critchley
Second Statewide Position	
Member	Alternate
Buck Klein	David Munger
Handler Members	
Member	Alternate
Bill Steed	Dan Clenney
Kable Munger	Brian Caster
Doug Perkins	Chase Higginbotham
Chad Hansen	Guy Cotton
Jayson Scarborough	Tom Avinelis
Public Member	
Vacant	Vacant

UNITED FRESH PUBLIC POLICY CONFERENCE

On September 24-26, 2018, the California Blueberry Commission will attend the United Washington Public Policy Conference. This conference is an annual event held in Washington DC, which provides the produce industry the opportunity to gather together and have a face to face dialogue with key members of Congress and address the industry's most pressing public policy matters. If you would like more information, please contact the Commission office.

PRODUCE MARKETING ASSOCIATION (PMA) FRESH SUMMIT

The Produce Marketing Association Fresh Summit's annual convention and exposition, will take place October 18-20, 2018, at the Orange County Convention Center in Orlando, Florida. PMA helps members grow by providing connections that expand business opportunities and increase sales and consumption. In addition, PMA allows the Commission to meet and maintain relationships with other industry leaders as it connects with the industry on current industry topics and workshops. In 2019, PMA will be held in Anaheim, California. For more information, please contact the Commission office.

NABC AND USHBC FALL MEETING

The North American Blueberry Council (NABC) and the United States Highbush Blueberry Council (USHBC) will conduct their fall meeting on October 3-5, 2018, at the Hyatt Centric French Quarter New Orleans in New Orleans, LA. The NABC and the USHBC will hold meetings for their respective committees, discussing current topics and updates. Industry members from around the country will have a chance to meet and discuss the blueberry industry at the semi-annual meeting. The NABC and USHBC next Spring meeting will be in San Diego, CA., 2019. For more information please visit (http://www.blueberry.org/meetings/) or contact the Commission office.

Blueberry Bites

BLUEBERRY DUMP CAKE

Ingredients:

1 box yellow cake mix

4 cups fresh California blueberries

½ cup sugar

1 teaspoon cinnamon

½ cup butter melted

Directions:

1. Preheat oven to 350 degrees
2. Mix blueberries, sugar and cinnamon in the bottom of a 9x13 inch pan. Cover the blueberries with the dry cake mix. Pour butter over cake mix, *do not stir*.
3. Bake for 30 minutes, or until light brown. Serve warm

Recipe courtesy of www.allrecipes.com.

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CALENDAR OF EVENTS

- Asia Fruit Logistica

  -Date: September 4-7, 2018

  -Hong Kong, China

- United Fresh Public Policy Conference

  -Date: Septmeber 24-26, 2018

  -Washington, D.C.

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CALIFORNIA Blueberry COMMISSION

Newsletter

Issue No. 22 September/October 2018

COMMISSION ATTENDS PMA

On October 18-20, 2018, the California Blueberry Commission attended the Produce Marketing Association's Fresh Summit's (PMA) annual convention and exposition, held at the Orange County Convention Center in Orlando, Florida. PMA helps members grow by providing connections that expand business opportunities and increase sales and consumption. In addition, PMA allows the Commission to meet and maintain relationships with other industry leaders, as it connects with the industry on being updated on current industry topics and workshops. In addition, the CBC partnered with California Grown to educate and distribute California blueberry materials throughout the trade show. In 2019, PMA will be held in Anaheim, California. For more information, please contact the Commission office.

CBC ANNOUNCES VACANCY ON THE BOARD OF DIRECTORS

The California Blueberry Commission is announcing a vacancy on the Board of Directors. This vacancy is for an alternate member for District Two. District Two, consists of all counties in the state that do not border the coastline and lie on the north boundaries of the Counties of Fresno, Inyo, and San Benito. Members typically meet once a year and all other business meetings are through conference calls. Individuals who are interested in this board appointment, and reside in District Two, please contact the CBC office for additional information.

US, CANADA & MEXICO REACH NEW TRADE AGREEMENT

The United States, Mexico, and Canada have reached a new trade deal to replace NAFTA. The new deal is renamed The United States-Mexico-Canada Agreement (USMCA) and focuses mostly on the automobile industry, however, works in factor of U.S. agriculture. While the agricultural provisions in Canada are focused mainly on the dairy, beef, pork, and grain industries, a zero tariff agreement was reached on all agricultural products traded between the U.S. and Mexico. Some factors that benefit the entire agricultural industry in all 3 countries include: modern language to enhance information exchange in relation to ag. biotechnology trade issues; science-based phytosanitary measures; grading standards and services agreement; and notification of SPS issues within 5 days, as opposed to 7. This new proposed agreement, however, is still in need of approval from Congress, and the CBC will provide an update when the timeline for approval becomes clearer after the upcoming election.

UNITED FRESH PUBLIC POLICY CONFERENCE

On September 24-26, 2018, the California Blueberry Commission staff attended the United Washington Public Policy Conference. This conference is an annual event held in Washington D.C., which provides the produce industry the opportunity to gather together and have a face to face dialogue with key members of Congress and address the industry's most pressing public policy matters. For example, issues concerning labor, trade and tariffs, newly announced ATP funding, and the security of MAP funds in the upcoming 2018 Farm Bill were discussed. If you would like more information, please contact the Commission office.

CBC ATTENDS NABC AND USHBC FALL MEETING

On October 3-5, 2018 the California Blueberry Commission (CBC) attended the North American Blueberry Council (NABC) and the United States Highbush Council (USHBC) meetings in New Orleans, LA. The NABC and the USHBC held meetings for their respective committees, discussing current topics and updates. Industry members from around the country had a chance to meet and discuss the blueberry industry at the annual meeting. The NABC and USHBC will be in San Diego, CA., in 2019. For more information please visit (http://www.blueberry.org/meetings/) or contact the Commission office.

CBC SEEKING PUBLIC MEMBER

The California Blueberry Commission (CBC) recommends appointments of a public member to the Board. Currently, the position of public member is vacant on the Board of Directors. According to the Commission Bylaws, the public member shall have all the powers, rights, and privileges of any other member or alternate, on the Commission. The appointment requires CDFA's approval for finalization of this position. Individuals who are interested in this Board appointment, please contact the CBC office for additional information.

CBC'S Elizabeth Carranza meets with Congressman Jim Costa

CBC ATTENDS AG IN THE CLASSROOM

As a member of the California Foundation for Agriculture in the Classroom, the CBC attended its first Ag. in the Classroom conference from September 27-29 in Palm Springs, CA. At this conference, the CBC had the opportunity to learn more about the program from organization leadership and California Department of Food and Agriculture secretary, Karen Ross. For any questions regarding the CBC's participation in this program or conference attendance, please do not hesitate to contact the Commission office.

New Intern

On September 17, 2018, we welcomed Nicole Helms as our newest intern. Nicole originates from Rio Oso and is attending CSU Fresno to pursue a degree in Agriculture Communications. She enjoys spending time with family and friends, being outdoors, and has a passion for agriculture. Nicole looks forward to the valuable knowledge that she will gain through this internship experience.

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CALENDAR OF EVENTS

- November 14-15 USAEDC (U.S. Agricultural Export Development Council) Conference- Baltimore, MD
- February 6-8 2019 Fruit Logistica- Berlin, Germany

CBC ANNUAL REPORT

In the near future, please be on the lookout for the California Blueberry Commission Annual Report. The Annual Report includes information on the current and future research, education projects, market reports, and other pertinent industry information. If you would like a hard copy, please contact the Commission office.

CBC MOVES OFFICE

We are excited to announce that the CBC office has moved. We are still located in the same office building, therefore, our address and telephone number remain the same, with the exception of our Suite Number. Please make a note of our **New Suite Number #152**. We hope you will stop in and say hi if you are in the area.

Blueberry Bites

BLUEBERRY CRUMBLE BARS

Ingredients:

1/2 teaspoon ground cinnamon
1 ½ cups all-purpose flour
1 ½ cups quick cooking oats
1 ½ cups quick cooking oats
½ teaspoon baking soda
2 cups California Blueberries
2 tablespoons cornstarch
2 tablespoons lemon juice

Directions:

1. Preheat oven to 375 degrees F.. Grease a 9x13-inch baking dish.
2. Combine flour, oats, 1 cup sugar, cinnamon, and baking soda in a large bowl. Cut butter into flour mixture until it resembles coarse crumbs. Reserve about 2 cups flour-butter mixture. Press remaining mixture into the prepared baking dish to form a crust.
3. Bring blueberries, remaining 1/2 cup sugar, cornstarch, and lemon juice to a boil in a saucepan, stirring constantly, until mixture is thickened, about 2 minutes. Spread blueberry mixture over crust and sprinkle with reserved oat mixture.
4. Bake in the preheated oven until topping is just browned, about 25 minutes. Cool before cutting and serving.

Recipe courtesy of www.allrecipes.com.

CALIFORNIA Blueberry COMMISSION

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